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ABSTRACT

Included are three units related to coastal and oceanic awareness. These are: (1) The "RA" Expeditions: The Archaeological and Anthropological Background; (2) The "RA" Expeditions: The Coriolis Effect; and (3) The "RA" Expeditions: The Papyrus Reed. Each of the three units are designed for students in grades 6-12. Each unit contains teacher background materials, student activity materials, evaluation materials, transparency masters, and selected references. (RH)

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THE "RA" EXPEDITIONS:
THE ARCHAEOLOGICAL AND ANTHROPOLOGICAL BACKGROUND

A Learning Experience for
Coastal and Oceanic
Awareness Studies

Produced by

MARINE ENVIRONMENT CURRICULUM STUDY
MARINE ADVISORY SERVICE
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and

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Please send evaluations

of learning experiences

to

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Newark, Delaware 19711

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TITLE: THE "RA" EXPEDITIONS: THE ARCHAEOLOGICAL AND ANTHROPOLOGICAL BACKGROUND

* CONCEPT: III.B.1.b.

III. The natural system influences the evolution of human culture.

B. The availability and utilization of resources contributed to the differentiation of life styles.

1. The invention of agriculture stimulated the differentiation of roles and led to the growth of technology.

b. INDIVIDUALS RELEASED FROM FOOD PRODUCTION DEVELOPED SPECIALIZATIONS RELATED TO AGRICULTURE.

** MARINE CONCEPT: 4.12

4. Man is part of the marine ecosystem.

4.1 The marine environment has affected the course of history and the development of human cultures.

4.12 PROXIMITY TO THE OCEANS AND THE AVAILABILITY OF MARINE RESOURCES HAVE INFLUENCED THE CULTURES OF MANY SOCIETIES.

GRADE LEVEL: 6-12

SUBJECT: Social Studies

CLASS PERIODS: 2-3

AUTHOR: Laggner and Osborne

NOTE TO THE TEACHER:

The scope of this lesson as it stands is of necessity limited by lack of time and space. The main points surrounding the work of Thor Heyerdahl have been covered, but this by no means is intended to be the final word. We sincerely hope that the teachers will use this material as a starting point from which to generate critical insight and interest among their students. A reasonable bibliography is provided to help the teacher make this lesson plan complete for the students.

This learning experience is designed to be used in conjunction with:

III.B.1.b. The "Ra" Expeditions: The Coriolis Effect (the force which determines direction of the winds and ocean currents) and

III.B.1.b. The "Ra" Expeditions: The Papyrus Reed (the type of reed used to make Heyerdahl's boat "Ra").

* From A Conceptual Scheme for Population-Environment Studies, 1973. Cost $2.50

** From Marine Environment Proposed Conceptual Scheme, 1973. No charge.

Both conceptual schemes are available from Robert W. Stegner, Population-Environment Curriculum Study, 310 Willard Hall, University of Delaware, Newark, DE 19711.

THE "RA" EXPEDITIONS

LEARNING OBJECTIVES

1. Students should have an idea of the current debate going on in the field of archaeology between the school of isolationism and that of diffusionism.

2. Students should have an understanding of the part Thor Heyerdahl's trans-Atlantic expeditions play in this debate.

3. Students should have an understanding of the part which ocean currents play in this debate.

PREPARATIONS AND INSTRUCTIONS

1. Make transparencies from the masters provided. To make reasonably clear transparencies darken the lighter lines of the masters with a soft lead pencil. The visual aids in this lesson plan are limited to overhead transparencies. However, the bibliography includes sources for excellent photographs, and their use will greatly enhance this lesson.

2. Administer the pre-test.

3. This lesson plan will be more successful for the students if they have some knowledge of the "Kon-Tiki" and "Ra" expeditions. The bibliography will be of help.

4. After the lesson is completed, administer the post-test.

TEACHER BACKGROUND

This lesson will use The "Ra" Expeditions, by Thor Heyerdahl, as a basis for inquiry into the linking of the ancient Mediterranean civilization with those of the ancient Middle Americans via the North Equatorial Current. Although not completely necessary, it is recommended that the teacher read The "Ra" Expeditions, as well as the other source material listed in the bibliography.

Columbus will never lose the credit for discovering America, but it must be remembered that he did not land on an empty beach. The perpetual trade winds and trans-Atlantic currents carried the "conquistadores" who followed Columbus to Mexico and Central America where they found organized Indian communities. The people the "conquistadores" found were the Aztecs of Central Mexico and the Incas, whose empire stretched from Panama, down the western coast of South America, to present-day Chile.

These pre-Columbian (meaning the time before Columbus' discovery) peoples had knowledge of the exact position of the equator, the equinox, the planets, and the stars. Their calendar was superior to that of the Old World. Their accomplishments also included surgery on the skeleton, as well as on the brain; construction of paved roads, aqueducts, suspension bridges, and pyramids; preparation of mummies; production of drugs; and the spinning, dyeing, and weaving of cotton cloth finer than the best in Europe.

The two trans-Atlantic expeditions of Thor Heyerdahl aboard the reed boat "Ra" were undertaken in part to help resolve an old battle between two schools of thought in the field of archaeology. The first of these schools, the isolationist, generally believes that similarities between two cultures do not mean that there was direct contact. For this to be, there must be historical (usually meaning written) or archaeological (usually meaning building sites and artifacts) proof. The implication here is that similarities between two cultures having no record of contact developed coincidentally. The other of the two schools, the diffusionist, believes that, except in rare cases, similarities between two cultures can be traced to diffusion, by means unknown, of ideas from one to the other. The diffusionists accuse the isolationists of holding a theory too narrow to explain cultural similarities. Further, they argue that their theory of diffusion is just as tenable as the isolationists' theory of coincidence in cultural similarities. However, the isolationists have a strong argument in questioning whether two or three castaways could significantly affect another culture.

Concerning the "Ra" expeditions, all archaeologists agree that the ancestors of American Indians were Stone Age peoples who crossed the frozen Bering Strait. The argument between the two schools centers around whether ancient American Indians had any outside help in developing to the point at which the Spanish found them in A.D. 1500. The diffusionists have postulated that there was contact with the ancient civilizations around the Mediterranean, giving as evidence such parallels as sun worship, belief that the king is descended from the sun god, mummification,

pyramid-type buildings oriented toward the movement of the sun, sophisticated mathematics and geometry to design and build pyramid and temple structures, various agricultural and architectural techniques, and reed boats. The isolationists believe that this evidence is purely circumstantial. If the Mediterranean cultures developed certain ways of doing things, why couldn't another culture separated by 2500 miles of ocean? The questions in this debate are far from settled, and even an attempt such as the "Ra" expeditions has not substantially altered the arguments of both schools.

Like the people of the ancient Mediterranean, the ancient Middle American Indians did not separate science and religion. A star, a day of the week, a number, and a god might all represent a single concept. Raimi, the sun god, was the highest of the Incan gods. He was the mathematical representation of the number 1. Viracocha, the mythical founder and high priest of the Incas, was said to be the white-skinned son of Raimi. The mythical founder of the Aztecs was Quetzalcoatl, who was white-skinned and was a god fathered by the sun. A similar pattern holds for Kukulcan, the religious founder of the Mayas. This is similar to the religion of the ancient Egyptians. The Pharoahs were believed to be descended from the Egyptian sun god, Ra.

If the founders of the royal line of the early Middle American Indians were white-skinned, then it should be no surprise that the "conquistadores" found a white royal family ruling a dark-skinned people. This had been done by inbreeding. The royal family would marry only among themselves. A separation was thus enforced between the rulers and the ruled, which encouraged a mystique of divinity to surround the royal family.

When members of the royal family died, they were buried in a manner similar to that of the ancient Egyptians. The bodies were mummified and buried in temples similar to the pyramids. If the king died, his servants were slain and buried with him so they would be able to serve him in the next world. The story of the deceased was written on the walls of the tomb.

Thor Heyerdahl notes that on both sides of the Atlantic the tomb writings often contain scenes of reed gathering, reed boat construction, and kings sailing in reed boats. The Spaniards found the South American Indians riding on small reed vessels that were nothing more than a tusk-shaped roller (see picture #9). The boats carried one or two men straddled as on a horse, their legs drifting in the water. Other reed boats were reported to be constructed as sailing vessels, able to support a crew of twenty-four. Heyerdahl believes that these vessels are the same as those unearthed at the pyramid of King Cheops in Egypt.

The reed is a tender water plant that can be bent by a child. It cannot be joined together with screws or nails. Dried reeds are tied together in bundles to form boats. Egyptian boats were built from the papyrus reed, Cyperus papyrus. The Western counterpart of this plant is Scirpus totora. Both reeds have all but vanished from the areas where they once flourished, yet in a few areas of the world reed boats are still the basic means of transportation.

The people of Lake Chad in Chad, Africa; Lake Tana in Ethiopia, Africa; Sardinia; Lake Titicaca on the border between Peru and Bolivia; and Easter Island still build their vessels in the shape of the Inca rollers (see pictures #6 through 9). Reed boats sit high in the water and need no bailing because excess water runs out through the spaces between the reeds.

Thor Heyerdahl notes the superiority of the reed vessels that have persisted through 5,000 years of history. Since he is sympathetic with the diffusionist school of thought, Heyerdahl set out to prove that reed vessels could have easily brought the culture of Egypt to the New World. To do this Heyerdahl employed boat builders from Lake Chad to construct his vessel. It was fashioned from papyrus reeds which came from Lake Tana at the source of the Nile. The vessel was named "Ra" after the Egyptian sun god. The "Ra" was patterned after the large reed skiffs unearthed at the pyramid of King Cheops.

On May 25, 1969, the "Ra" set sail from Safi, Morocco, with a crew of seven. During the first two days of the voyage across the Atlantic Ocean, the winds stripped the "Ra" of her sail and oars. She was able to drift with the Canary Current and later the North Equatorial Current. On July 16, the crew was forced to abandon the sinking "Ra" east of Barbados. Her stern had not been constructed as a single unit with the rest of the ship, and the boat had started to disintegrate and sink. During the following year, Heyerdahl had a second reed boat constructed. The "Ra II" was built as a single unit and successfully crossed in the path of "Ra I" during the summer of 1970.

Despite his efforts, Heyerdahl realized that a trans-Atlantic crossing is still theoretical. He proved that reed boats are quite seaworthy, but the archaeological argument still continues.

PRE-TEST

1. What are the possibilities that people crossed the Atlantic Ocean before the time of Columbus in 1492?

   It has been proven through the investigations of Scandinavian archaeologists that a Viking settlement existed at L'Anse aux Meadows on Newfoundland about A.D. 986. After the "Ra" and "Kon-Tiki" expeditions by Thor Heyerdahl, it is quite plausible that throughout history stray and storm-damaged boats drifted with the current to the Americas.

2. If the possibility above is assumed for the moment, speculate as to how many people would be necessary to influence an already existing primitive culture.

   Theoretically, only one person would be needed. The chances would be greatly improved if there were enough people to guarantee offspring for a long period of time, e.g., 100 years. This stipulation is made because two or three generations would be needed to transmit the knowledge of the arriving group to the primitive culture. People who disagree with Heyerdahl's thesis agree that trans-oceanic contact is too questionable for sound archaeological study. Positive evidence must be found, as in the case of the Viking settlement.

3. What is an ocean current?

   An ocean current is literally a stream in the ocean. Usually ocean currents have different salinities and temperatures than the surrounding water.

4. In what general direction do ocean currents flow in each hemisphere?

   Generally the Coriolis effect causes ocean currents to flow clockwise, to the right, north of the equator and counterclockwise, to the left, south of the equator. Their direction is also determined by the shape of the continental coast as well as the ocean floor.

5. On the map of ocean currents provided on page 8, locate the North Equatorial Current and the Canary Current. (A National Geographic world map is most helpful.)

   The North Equatorial Current is located 10° to 15° north latitude in the Atlantic Ocean. The Canary Current runs southerly along the northwest coast of Africa. See labeled map on page 9.

6. Do you think ocean currents have played a major role or a minor role in the transfer of cultures? Explain why. (Students' answers may vary.)

   The Vikings and Columbus deliberately sailed west; there are other instances where people deliberately sailed to new lands. Before people searched for new lands across the seas and before people overcame their fear of the ocean, currents acted as the subtle, yet constant, force in the movement of people from one part of the world to another.

POST-TEST

Questions 1 through 6 the same as in Pre-test.

7. Write an essay comparing the civilizations of ancient Egypt and the ancient Middle Americans, including religion, water transportation, and architecture.

   The similarities are many but should include:

   Religion - For both cultures the highest diety was the sun god, and their rulers were believed to be his descendants. They also had very powerful high priests who set the calendar, decided religious matters, and were the most knowledgeable in the arts and science.

   Water Transportation - Reed boats of similar construction were widely used in both cultures.

   Architecture - The religious buildings were shaped like pyramids with long mounting steps.

8. Look at a map of the world's ocean currents and pick out other currents which might possibly have been used by man in his movements from one continent to another.

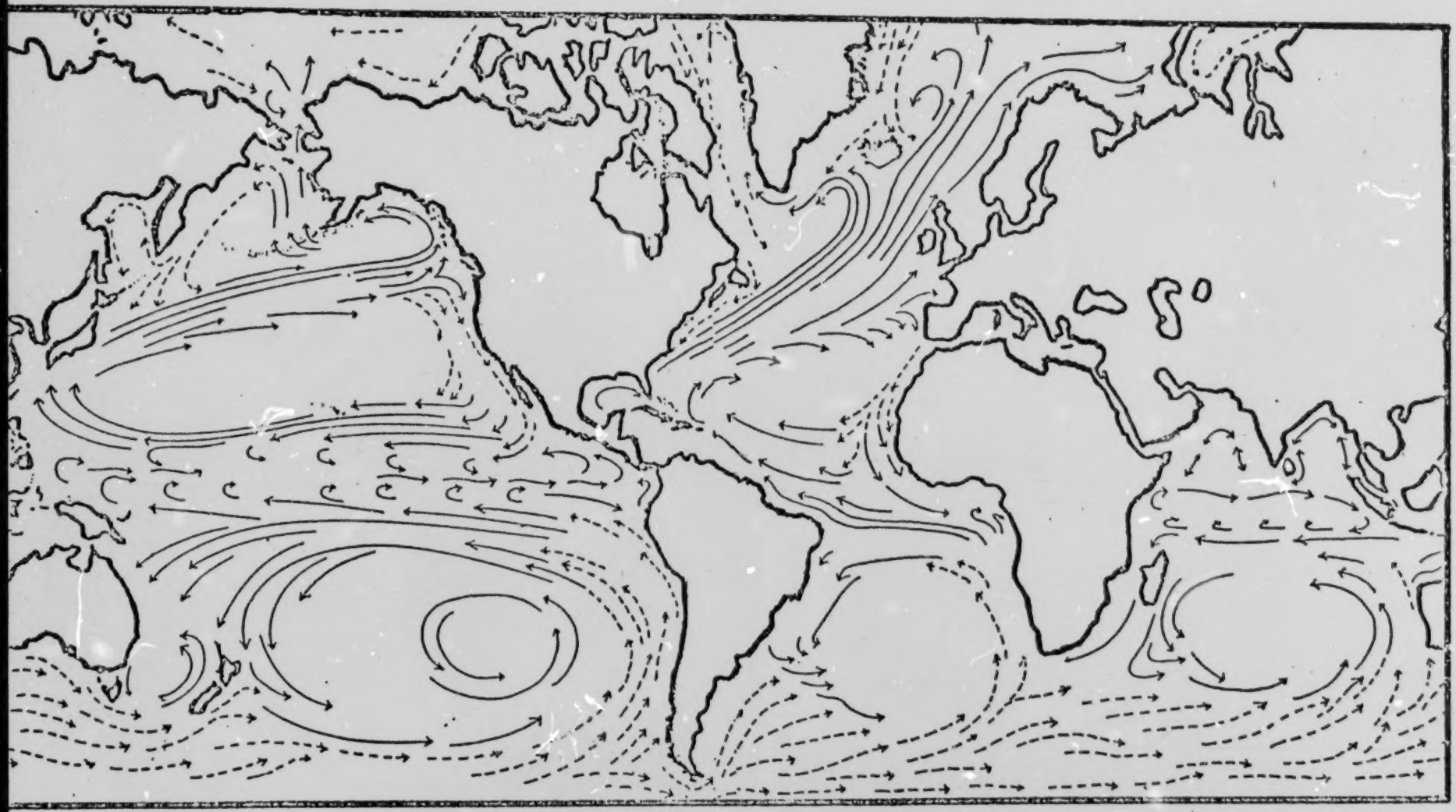
   Some possibilities are:

   Japan (Kuroshio) and North Pacific Currents from Japan and China to the Hawaiian Islands and the west coast of North America.

   Humboldt and South Equatorial Currents in the South Pacific Ocean from the west coast of South America to the islands of the Southern Pacific and Australia.

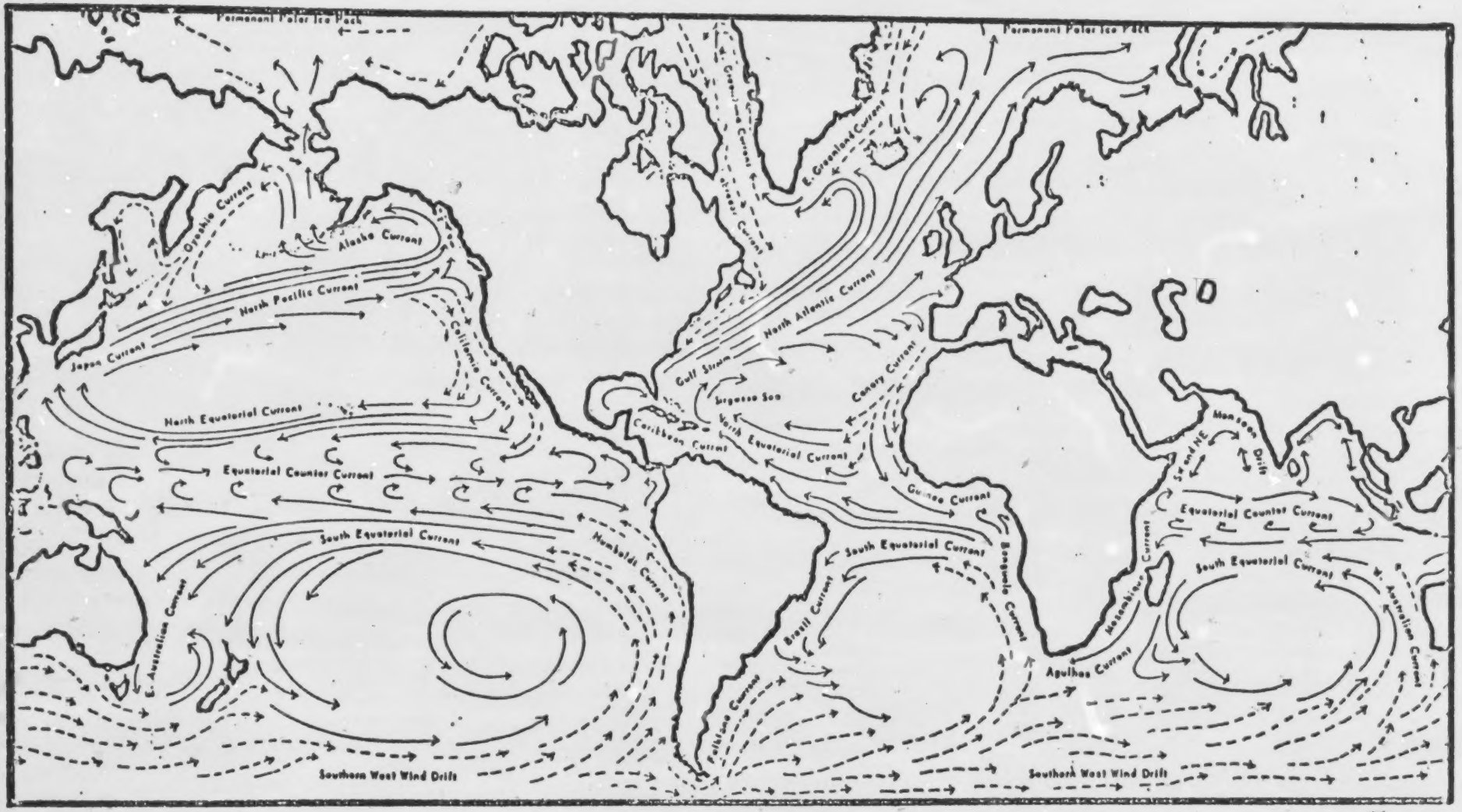
   South Equatorial and Brazil Currents in the south Atlantic Ocean from the west coast of Africa to the east coast of South America.

MAJOR OCEAN CURRENTS OF THE WORLD



WARM CURRENTS - ——
COLD CURRENTS - - - -

MAJOR OCEAN CURRENTS OF THE WORLD



WARM CURRENTS - ———
COLD CURRENTS - - - -

Inquiry into the "Ra" Expeditions--A Student Reading

This discussion will compare the culture of ancient Middle American Indians with that of ancient Egyptians to see whether the basis for the expeditions undertaken by Thor Heyerdahl across the Atlantic in 1969 and 1970 was valid.

Can you name any tribes from ancient Middle America?

The Aztecan, Incan, and Mayan tribes are considered to be the high points of the cultural and political development of the ancient Middle American Indians. There were hundreds of other tribes both related to, and distinct from, these famous three.

Where was each of these tribes found and when did each tribe flourish?

The Aztecs were the most northern. They were situated in the Valley of Mexico, around present-day Mexico City. They flourished from A.D. 1200 to 1521. The Incas lived along a 2500-mile stretch of the Andes Mountains in what is today Peru, Ecuador, Bolivia, and Chile. Their culture flourished from A.D. 1450 to 1532. The Aztecan and the Incan cultures had been destroyed by the Spanish by A.D. 1532. The Mayans occupied present-day Guatemala, British Honduras, and parts of southern Mexico, including the Yucatan. They flourished from A.D. 300 to 800.

Can you explain this picture? (Look at picture #1.)

This is a drawing of a Mayan temple structure. Here elaborate sacrifices and ceremonies to the gods were performed. Also, priests lived here collecting astronomical information as well as performing religious duties. This temple structure is located at Uxmal, an ancient city-site of Mayans called the Xiu tribe.

What do you notice about this temple structure? (Look at picture #2.)

It is similar to picture #1. This is a drawing of a temple in an area occupied by the Mixtecs, a tribe related to the Aztecs, at Mount Alban, Mexico. Look at picture #3. This drawing is of the famous temple Chichen Itza, built by a people called the Itza and located in the Yucatan. They were a people influenced by the Mayas and by the Toltecs, a tribe related to the Aztecs.

What similarities can you find among all three temple structures?

All have a similar form: broad, high steps leading to the temple proper; pyramidal shape; structural features revealing a certain mathematical sophistication.

What other culture has pyramid-shaped structures?

The ancient Egyptian.

What were pyramids used for by the ancient Egyptians?

Primarily, the pyramids served as tombs for the Pharoahs. However, they also had attached to them communities of priests who collected large amounts of medical and astronomical information. This was done to establish an accurate calendar for the prediction of upcoming religious feasts and the annual rising of the Nile. Look at pictures #4 and #5. These are drawings of the Temple of Hatsheput, located near Thebes on the Nile. Hatsheput (1503-1483 B.C.) was one of the few queens of ancient Egypt. Her husband, Tuthmosia II, died leaving an infant son. She took control of the throne and had this temple built in her honor. When her son finally deposed her, he had the temple partially razed.

Do you see any similarities between these two pictures and those of the ancient Middle American Indians?

There is a series of raised platforms, mounted by steps. The top platform held the temple proper. Also, the pyramids of ancient Egypt and the temple structures shown in pictures #1, #2, and #3 were built facing the four cardinal directions, north, east, south, and west.

Are there any other similarities between the cultures of ancient Egypt and ancient Middle America?

1. The cultures of the ancient Incans and the ancient peoples on Easter Island in the Pacific believed in a sun god who was the ancestor of their rulers. This meant that all their rulers had a divine origin. Further, when the Spanish "conquistadores" first came to Middle America in the early 1500's, they were welcomed as divine relatives of the Indian king's own ancestor, the sun god. Apparently, ancient Middle American Indians had

seen or knew of white-skinned men at a time long before the "conquistadores" came.

2. Another similarity is the reed boat. Drawings of the reed boats in the following pictures are from Lake Chad in Chad (picture #6); Lake Tana in Ethiopia at the source of the Nile River (picture #7); Easter Island, in the South Pacific (picture #8); the Gulf of California in Mexico (picture #9). There are basic similarities in that they are made by reeds bound together with rope or twine. Also, pictures #10, 11, and 12 are sketches of reliefs in Egyptian tombs showing the construction of papyrus reed boats in ancient times. (At this point, discuss what conclusions can be drawn from the information given so far. It is important that your conclusions be subject to verification by the information given in this lesson or gathered from other sources. Thor Heyerdahl's theory is quite plausible, but it has been challenged by serious and valid objections from other sectors of the archaeological and anthropological communities.)

Let us see if there is any possibility that trans-Atlantic contact could have been made.

<u>If reed boats were in fact used, what forces would be necessary to get from one side of the Atlantic to the other</u>?

Winds and ocean currents would be necessary. Sails and a suitable steering system would be needed to harness these forces. On the map on page 8, pick out the ocean currents most likely to be used in a trans-Atlantic crossing of Mediterranean peoples to the New World.

<u>What are the names of these currents</u>? (Look at picture #13)

They are called the Canary and North Equatorial Currents.

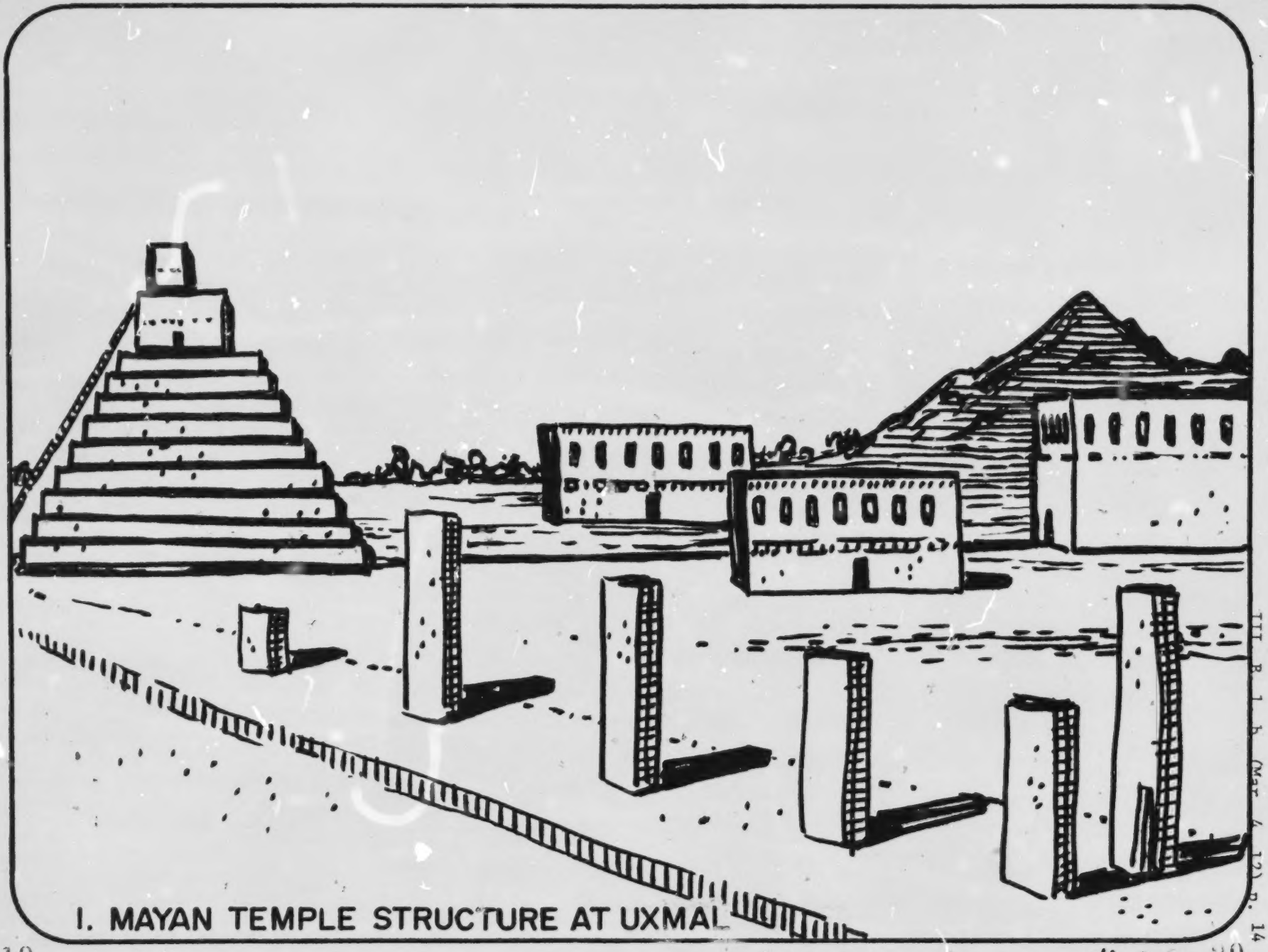
What winds prevail over these currents?

The Northeast Trade Winds prevail.

Can you explain why ancient peoples crossing the Atlantic did not land in North America?

The winds and ocean currents used by the ancient peoples did not blow and flow directly to North America.

Thor Heyerdahl set out to prove the possibility of a trans-Atlantic crossing before the time of Columbus. He succeeded with, as he states in his book, very little sophistication of ship design and very little practical knowledge as a seaman. Is this enough evidence to prove a trans-Atlantic link before the time of Columbus? Here is the actual route taken by the boat "Ra."(Look at picture #14.)



I. MAYAN TEMPLE STRUCTURE AT UXMAL

#1

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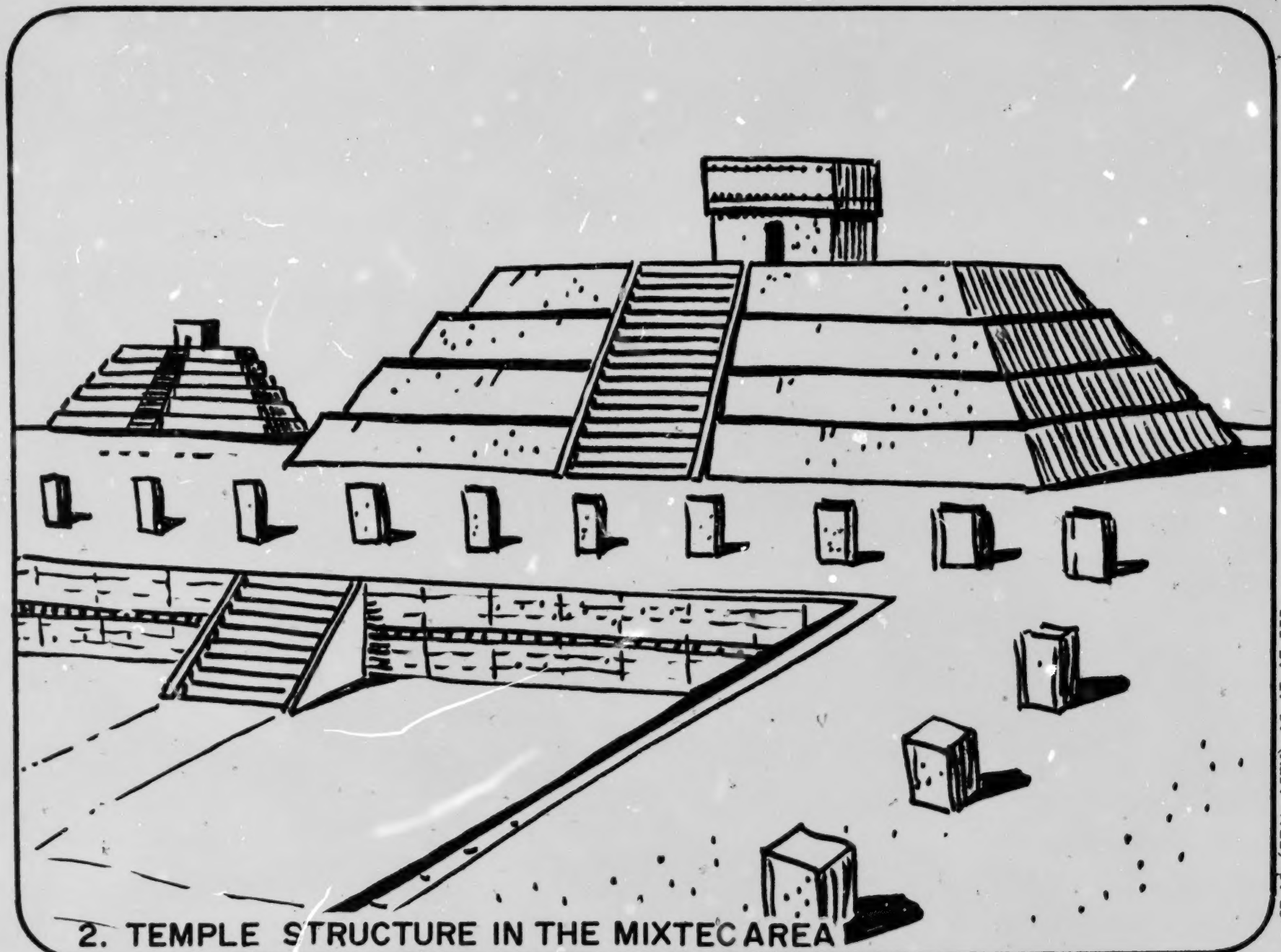
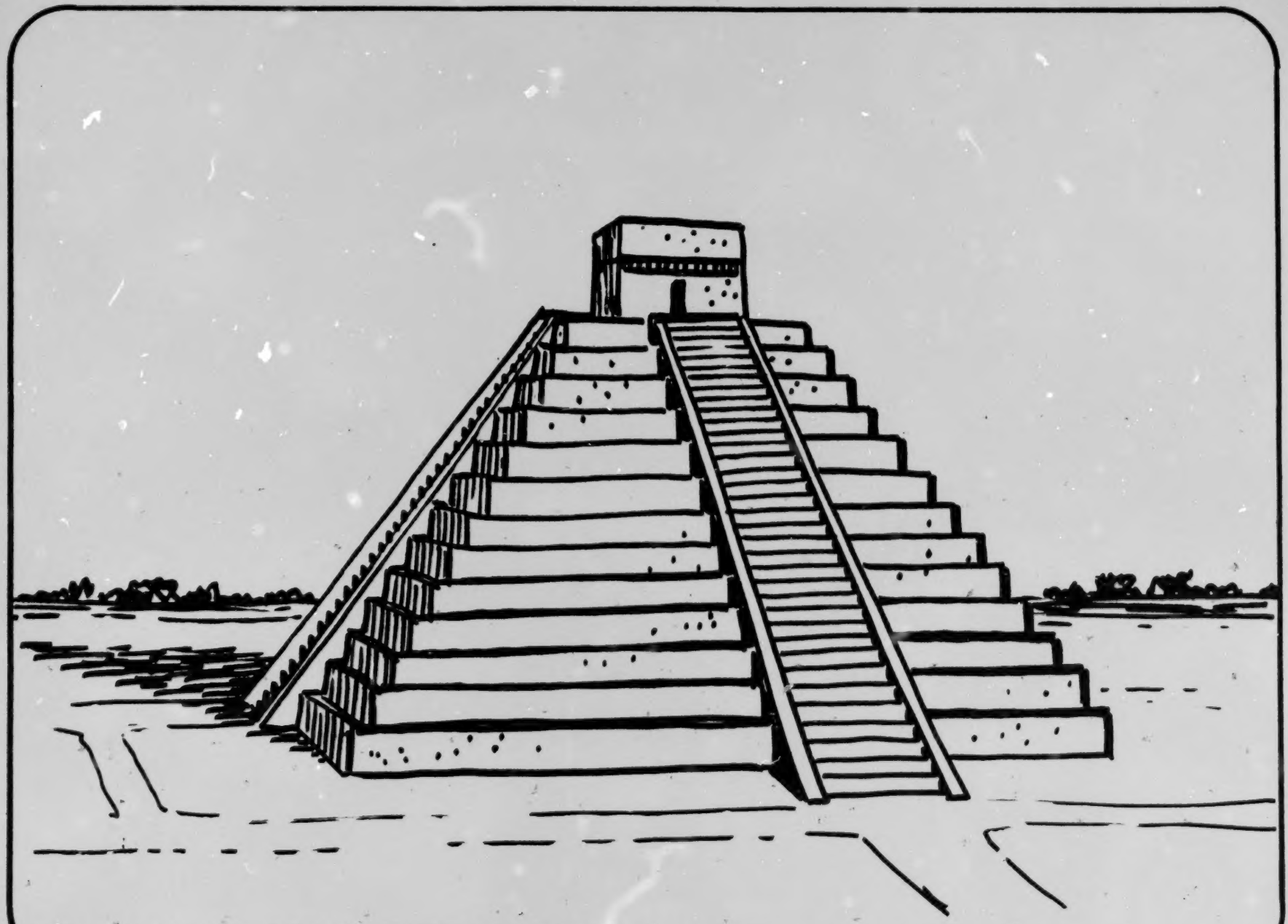


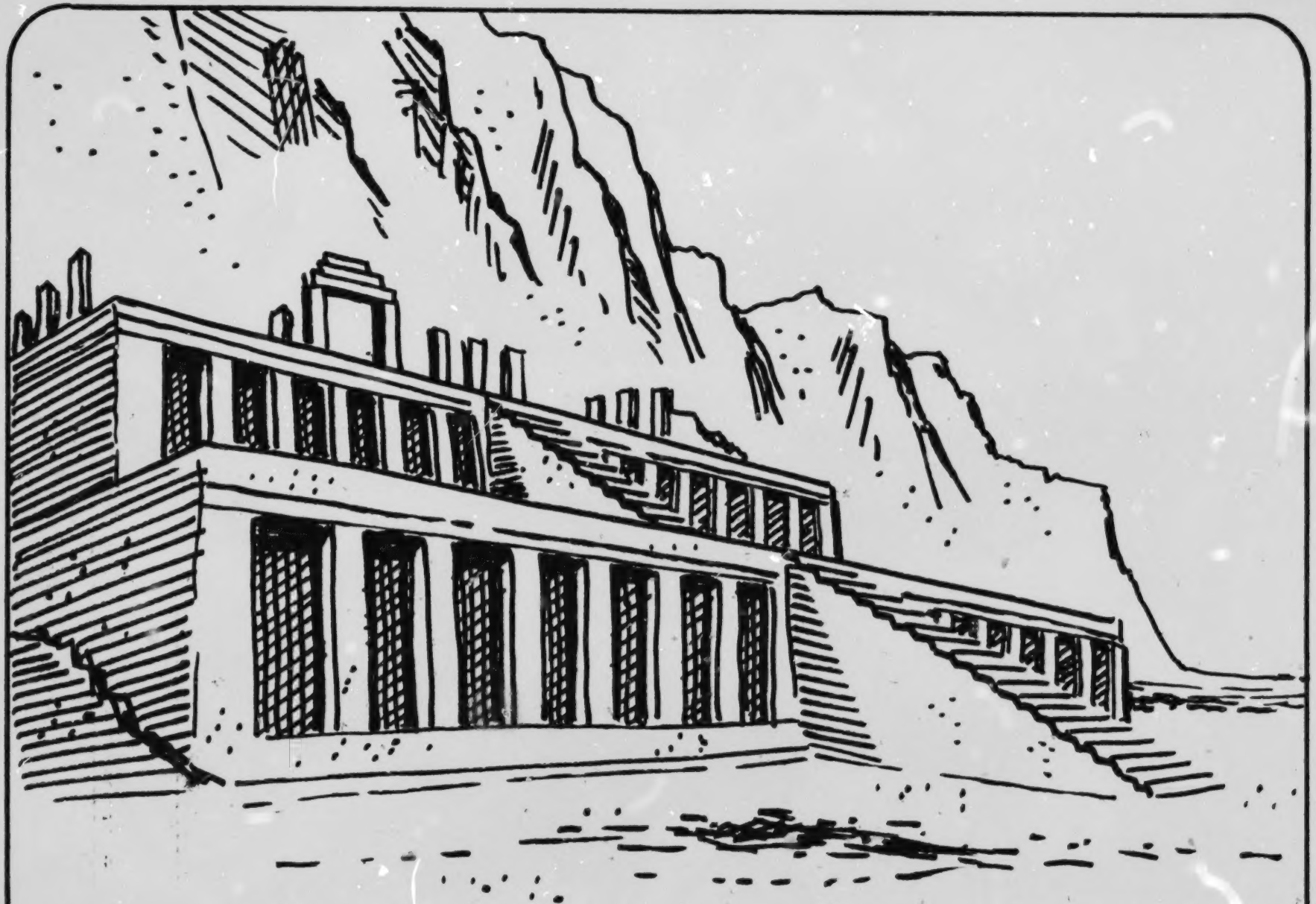
2. TEMPLE STRUCTURE IN THE MIXTEC AREA

#2



3. TEMPLE STRUCTURE OF CHICHEN ITZA

#3



4. TEMPLE STRUCTURE OF THE EGYPTIAN, HATSHEPUT, GROUND VIEW

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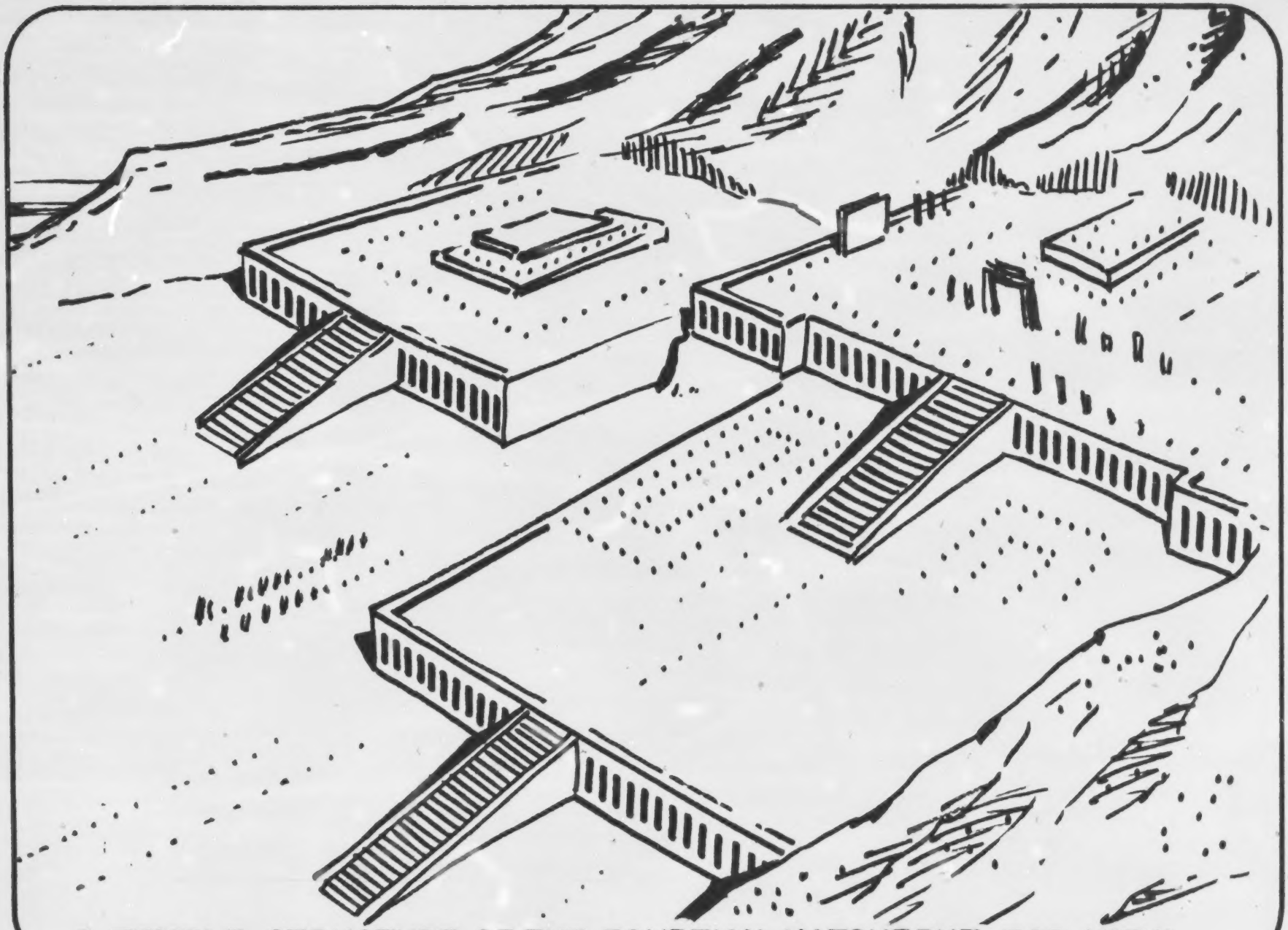
#4



5. TEMPLE STRUCTURE OF THE EGYPTIAN, HATSHEPUT, TOP VIEW

5

6. REED BOAT FROM LAKE CHAD

#6

7. REED BOAT FROM LAKE TANA

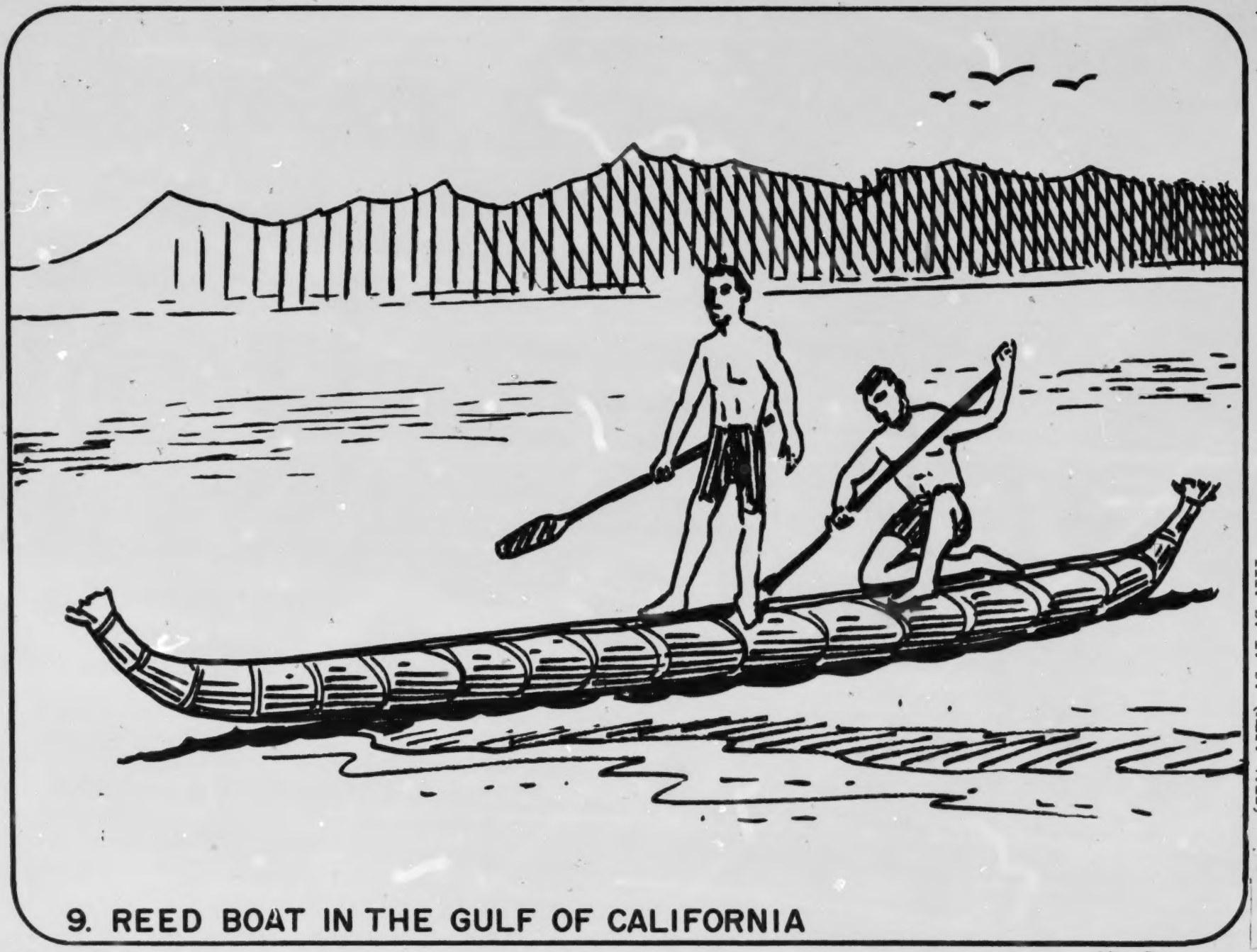
#7

III. B. 1. b. (Mar. 4.12)

8. REED BOAT OFF EASTER ISLAND

#8

III. B. 1. b. (Mar. 4.12) p. 21



9. REED BOAT IN THE GULF OF CALIFORNIA

#9

Ill. B. I. b. (Mar. 4.12)

10. EGYPTIAN PYRAMID RELIEF SHOWING REED BOAT CONSTRUCTION

#10

11. EGYPTIAN PYRAMID RELIEF SHOWING REED BOAT CONSTRUCTION

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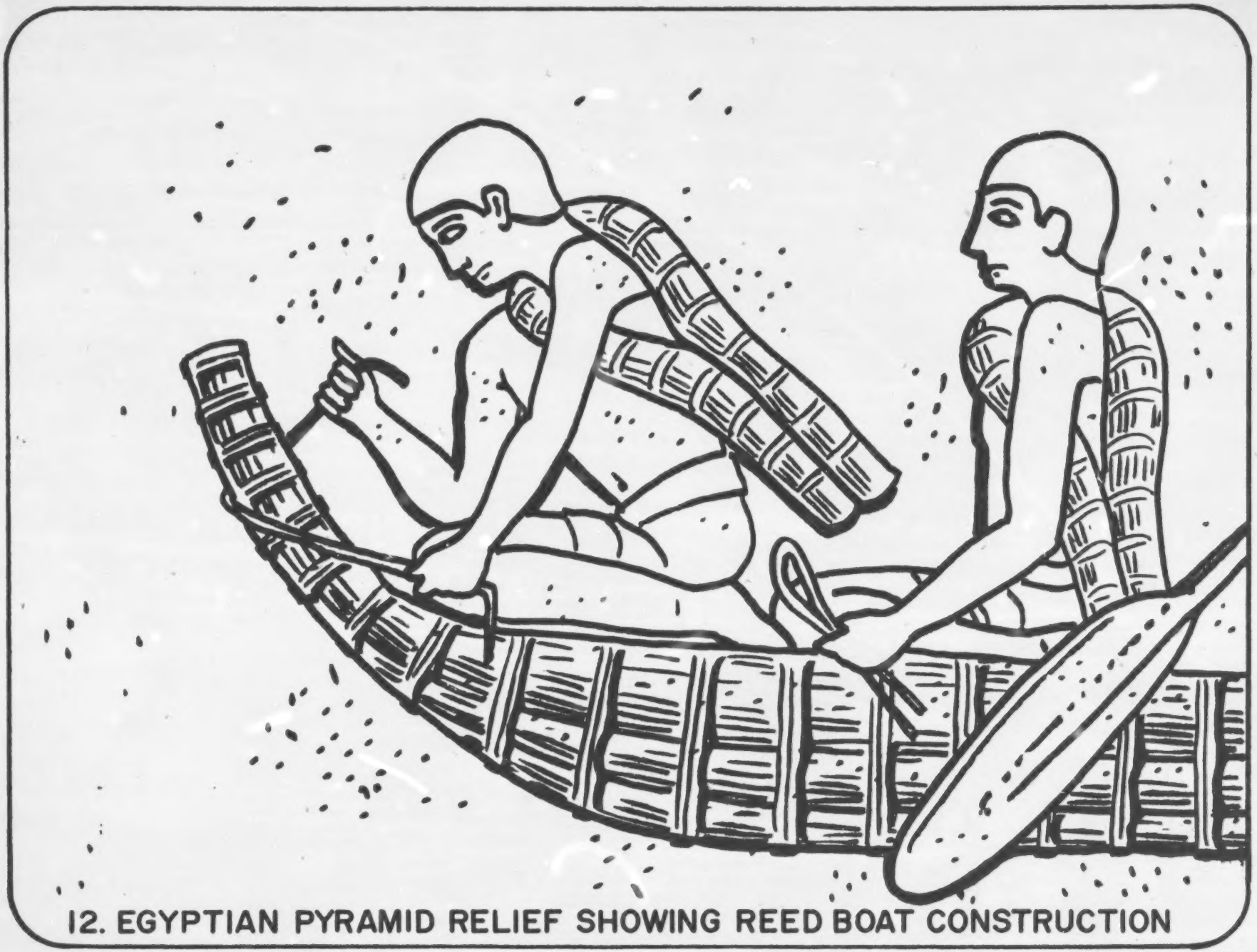
#11



12. EGYPTIAN PYRAMID RELIEF SHOWING REED BOAT CONSTRUCTION

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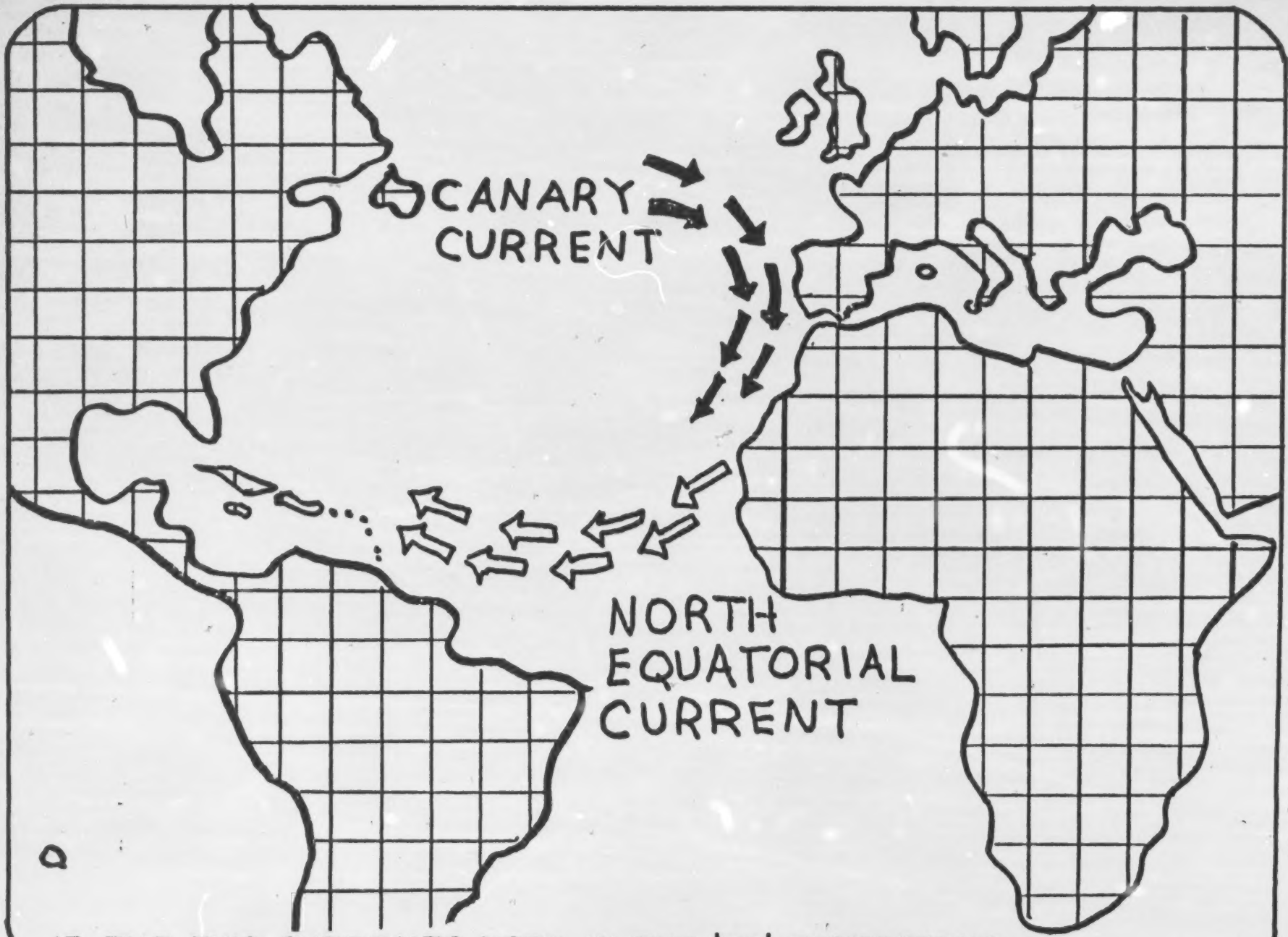
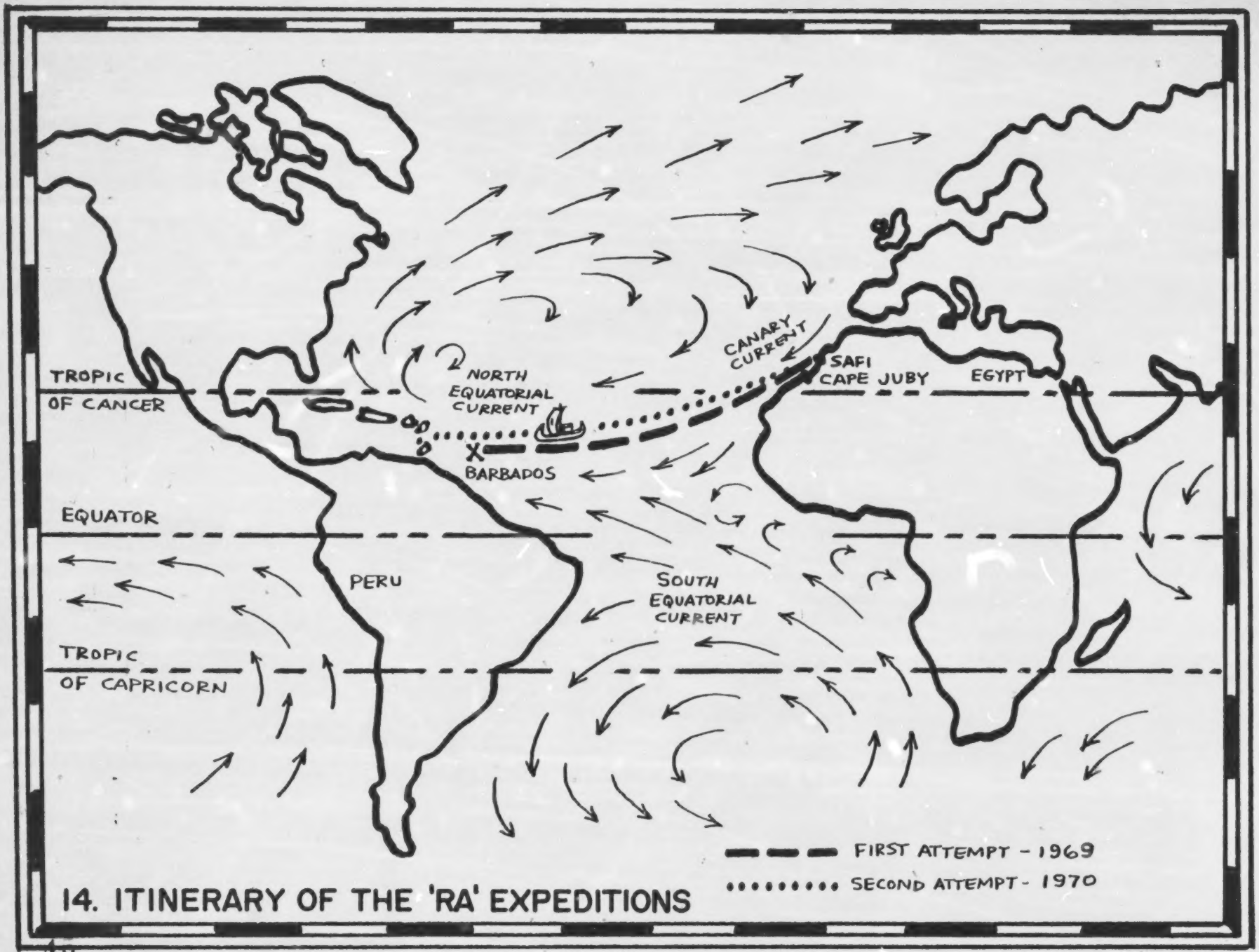
III. B. 1. b. (Mar. 4.12) p. 25



13. THE TWO CURRENTS USED IN THE 'RA' EXPEDITIONS

#13

III. B. 1. b. (Mar. 4.12) p. 26



14. ITINERARY OF THE 'RA' EXPEDITIONS

III. B. 1. b. (Mar. 4. 12) p. 27

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THE "RA" EXPEDITIONS: THE CORIOLIS EFFECT

A Learning Experience for
Coastal and Oceanic
Awareness Studies

Produced by

MARINE ENVIRONMENT CURRICULUM STUDY
MARINE ADVISORY SERVICE
UNIVERSITY OF DELAWARE

and

POPULATION-ENVIRONMENT CURRICULUM STUDY
COLLEGE OF EDUCATION
UNIVERSITY OF DELAWARE

as part of a

PLAN FOR ENVIRONMENTAL EDUCATION

Fall 1974

Please send evaluations

of learning experiences

to

Dr. Robert W. Stegner, Director

COAST Project

310 Willard Hall Education Building

University of Delaware

Newark, Delaware 19711

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TITLE: THE "RA" EXPEDITIONS: THE CORIOLIS EFFECT

* CONCEPT: III.B.1.b.

III. The natural system influences the evolution of human culture.

B. The availability and utilization of resources contributed to the differentiation of life styles.

1. The invention of agriculture stimulated the differentiation of roles and led to the growth of technology.

b. INDIVIDUALS RELEASED FROM FOOD PRODUCTION DEVELOPED SPECIALIZATIONS RELATED TO AGRICULTURE.

** MARINE CONCEPT: 4.12

4. Man is part of the marine ecosystem.

4.1 The marine environment has affected the course of history and the development of human cultures.

4.12 PROXIMITY TO THE OCEANS AND THE AVAILABILITY OF MARINE RESOURCES HAVE INFLUENCED THE CULTURES OF MANY SOCIETIES.

GRADE LEVEL: 6-12

SUBJECT: Social Studies

CLASS PERIODS: 2-3

AUTHORS: Laggner and Osborne

NOTE TO THE TEACHER:

The scope of this lesson as it stands is of necessity limited by lack of time and space. The main points surrounding the work of Thor Heyerdahl have been covered, but this by no means is intended to be the final word. We sincerely hope that the teachers will use this material as a starting point from which to generate critical insight and interest among their students. A reasonable bibliography is provided to help the teacher make this lesson plan complete for the students.

This learning experience is designed to be used in conjunction with:

III.B.1.b. The "Ra" Expeditions: The Archaeological and Anthropological Background and

III.B.1.b. The "Ra" Expeditions: The Papyrus Reed (the type of reed used to make Thor Heyerdahl's boat "Ra").

* From A Conceptual Scheme for Population-Environment Studies, 1973. Cost $2.50.

** From Marine Environment Proposed Conceptual Scheme, 1973. No charge.

Both conceptual schemes are available from Robert W. Stegner, Population-Environment Curriculum Study, 310 Willard Hall, University of Delaware, Newark, DE 19711.

THE "RA" EXPEDITIONS

LEARNING OBJECTIVES

1. Students should have an idea of the current debate going on in the field of archaeology between the school of isolationism and that of diffusionism.

2. Students should have an understanding of the part Thor Heyerdahl's trans-Atlantic expeditions played in this debate.

3. Students should have an understanding of the part which ocean currents played in this debate.

4. Students should have a basic understanding of the dynamics of the Coriolis Effect and the influence it exerts on wind and ocean current systems.

PREPARATIONS AND INSTRUCTIONS

1. Make transparencies from the masters provided. Note: to make reasonably clear transparencies, shade in the lighter parts of the masters with a #2 pencil. The visual aids in this lesson plan are limited to overhead transparencies. However, the bibliography includes sources for excellent photographs, and their use will greatly enhance this lesson.

2. Administer the pre-test. Some questions may be deleted, depending on the scope of the lesson.

3. This lesson will be more successful for the students if they have some knowledge of the "Kon-Tiki" and "Ra" expeditions.

4. After the lesson is completed, administer the post-test and/or the questions included in activity #4, p. 12.

TEACHER BACKGROUND

This lesson will use The "Ra" Expeditions, by Thor Heyerdahl, as a basis for inquiry into the linking of the ancient Mediterranean civilization with those of the ancient Middle Americans via the North Equatorial Current. Although not completely necessary, it is recommended that the teacher read The "Ra" Expeditions, as well as the other source material listed in the bibliography.

Columbus will never lose the credit for discovering America, but it must be remembered that he did not land on an empty beach. The perpetual trade winds and trans-Atlantic currents carried the "conquistadores" who followed Columbus to Mexico and Central America where they found organized Indian communities. The people the "conquistadores" found were the Aztecs of Central Mexico and the Incas, whose empire stretched from Panama, down the western coast of South America, to present-day Chile.

These pre-Columbian (meaning the time before Columbus' discovery) peoples had knowledge of the exact position of the equator, the equinox, the planets, and the stars. Their calendar was superior to that of the Old World. Their accomplishments also included surgery on the skeleton, as well as on the brain; construction of paved roads, aqueducts, suspension bridges, and pyramids; preparation of mummies; production of drugs; and the spinning, dyeing, and weaving of cotton cloth finer than the best in Europe.

The two trans-Atlantic expeditions of Thor Heyerdahl aboard the reed boat "Ra" were undertaken in part to help resolve an old battle between two schools of thought in the field of archaeology. The first of these schools, the isolationist, generally believes that similarities between two cultures do not mean that there was direct contact. For this to be, there must be historical (usually meaning written) or archaeological (usually meaning building sites and artifacts) proof. The implication here is that similarities between two cultures having no record of contact developed coincidentally. The other of the two schools, the diffusionist, believes that, except in rare cases, similarities between two cultures can be traced to diffusion, by means unknown, of ideas from one to the other. The diffusionists accuse the isolationists of holding a theory too narrow to explain cultural similarities. Further, they argue that their theory of diffusion is just as tenable as the isolationists' theory of coincidence in cultural similarities. However, the isolationists have a strong argument in questioning whether two or three castaways could significantly affect another culture.

Concerning the "Ra" expeditions, all archaeologists agree that the ancestors of American Indians were Stone Age peoples who crossed the frozen Bering Strait. The argument between the two schools centers around whether ancient American Indians had any outside help in developing to the point at which the Spanish found them in A.D. 1500. The diffusionists have postulated that there was contact with the ancient civilizations around the Mediterranean, giving as evidence such parallels as sun worship, belief that the king is descended from the sun god, mummification,

pyramid-type buildings oriented toward the movement of the sun, sophisticated mathematics and geometry to design and build pyramid and temple structures, various agricultural and architectural techniques, and reed boats. The isolationists believe that this evidence is purely circumstantial. If the Mediterranean cultures developed certain ways of doing things, why couldn't another culture separated by 2500 miles of ocean? The questions in this debate are far from settled, and even an attempt such as the "Ra" expeditions has not substantially altered the arguments of both schools.

Like the people of the ancient Mediterranean, the ancient Middle American Indians did not separate science and religion. A star, a day of the week, a number, and a god might all represent a single concept. Raimi, the sun god, was the highest of the Incan gods. He was the mathematical representation of the number 1. Viracocha, the mythical founder and high priest of the Incas, was said to be the white-skinned son of Raimi. The mythical founder of the Aztecs was Quetzalcoatl, who was white-skinned and was a god fathered by the sun. A similar pattern holds for Kukulcan, the religious founder of the Mayas. This is similar to the religion of the ancient Egyptians. The Pharoahs were believed to be descended from the Egyptian sun god, Ra.

If the founders of the royal line of the early Middle American Indians were white-skinned, then it should be no surprise that the "conquistadores" found a white royal family ruling a dark-skinned people. This had been done by inbreeding. The royal family would marry only among themselves. A separation was thus enforced between the rulers and the ruled, which encouraged a mystique of divinity to surround the royal family.

When members of the royal family died, they were buried in a manner similar to that of the ancient Egyptians. The bodies were mummified and buried in temples similar to the pyramids. If the king died, his servants were slain and buried with him so they would be able to serve him in the next world. The story of the deceased was written on the walls of the tomb.

Thor Heyerdahl notes that on both sides of the Atlantic the tomb writings often contain scenes of reed gathering, reed boat construction, and kings sailing in reed boats. The Spaniards found the South American Indians riding on small reed vessels that were nothing more than a tusk-shaped roller (see picture #9).* The boats carried one or two men straddled as on a horse, their legs drifting in the water. Other reed boats were reported to be constructed as sailing vessels, able to support a crew of twenty-four. Heyerdahl believes that these vessels are the same as those unearthed at the pyramid of King Cheops in Egypt.

The reed is a tender water plant that can be bent by a child. It cannot be joined together with screws or nails. Dried reeds are tied together in bundles to form boats. Egyptian boats were built from the papyrus reed, Cyperus papyrus. The Western counterpart of this plant is Scirpus totora. Both reeds have all but vanished from the areas where they once flourished, yet in a few areas of the world reed boats are still the basic means of transportation.

The people of Lake Chad in Chad, Africa; Lake Tana in Ethiopia, Africa; Sardinia; Lake Titicaca on the border between Peru and Bolivia; and Easter Island still build their vessels in the shape of the Inca rollers (see pictures #6 through 9).* Reed boats sit high in the water and need no bailing because excess water runs out through the spaces between the reeds.

Thor Heyerdahl notes the superiority of the reed vessels that have persisted through 5,000 years of history. Since he is sympathetic with the diffusionist school of thought, Heyerdahl set out to prove that reed vessels could have easily brought the culture of Egypt to the New World. To do this Heyerdahl employed boat builders from Lake Chad to construct his vessel. It was fashioned from papyrus reeds which came from Lake Tana at the source of the Nile. The vessel was named "Ra" after the Egyptian sun god. The "Ra" was patterned after the large reed skiffs unearthed at the pyramid of King Cheops.

On May 25, 1969, the "Ra" set sail from Safi, Morocco, with a crew of seven. During the first two days of the voyage across the Atlantic Ocean, the winds stripped the "Ra" of her sail and oars. She was able to drift with the Canary Current and later the North Equatorial Current. On July 16, the crew was forced to abandon the sinking "Ra" east of Barbados. Her stern had not been constructed as a single unit with the rest of the ship, and the boat had started to disintegrate and sink. During the following year, Heyerdahl had a second reed boat constructed. The "Ra II" was built as a single unit and successfully crossed in the path of "Ra I" during the summer of 1970.

Despite his efforts, Heyerdahl realized that a trans-Atlantic crossing is still theoretical. He proved that reed boats are quite seaworthy, but the archaeological argument still continues.

*Because this learning experience was developed in conjunction with two other learning experiences (The "Ra" Expeditions: The Archaeological and Anthropological Background and The "Ra" Expeditions: The Coriolis Effect) the numbering of the figures is not consecutive. The pictures can be found on pp. 14-20.)

PRE-TEST

1. What are the possibilities that people crossed the Atlantic Ocean before the time of Columbus in 1492?

   It has been proven through the investigations of Scandinavian archaeologists that a Viking settlement existed at L'Anse aux Meadows on Newfoundland about A.D. 986. After the "Ra" and "Kon-Tiki" expeditions by Thor Heyerdahl, it is quite plausible that throughout history stray and storm-damaged boats drifted with the current to the Americas.

2. If the possibility above is assumed for the moment, speculate as to how many people would be necessary to influence an already existing primitive culture.

   Theoretically, only one person would be needed. The chances would be greatly improved if there were enough people to guarantee offspring for a long period of time, e.g., 100 years. This stipulation is made because two or three generations would be needed to transmit the knowledge of the arriving group to the primitive culture. People who disagree with Heyerdahl's thesis agree that trans-oceanic contact is too questionable for sound archaeological study. Positive evidence must be found, as in the case of the Viking settlement.

3. What is an ocean current?

   An ocean current is literally a stream in the ocean. Usually ocean currents have different salinities and temperatures than the surrounding water.

4. In what general direction do ocean currents flow in each hemisphere?

   Generally the Coriolis effect causes ocean currents to flow clockwise, to the right, north of the equator and counterclockwise, to the left, south of the equator. Their direction is also determined by the shape of the continental coast as well as the ocean floor.

5. On the map of ocean currents provided on page 8, locate the North Equatorial Current and the Canary Current. (A National Geographic world map is most helpful.)

   The North Equatorial Current is located 10° to 15° north latitude in the Atlantic Ocean. The Canary Current runs southerly along the northwest coast of Africa. See labeled map on page 9.

6. Do you think ocean currents have played a major role or a minor role in the transfer of cultures? Explain why. (Students' answers may vary.)

   The Vikings and Columbus deliberately sailed west; there are other instances where people deliberately sailed to new lands. Before people searched for new lands across the seas and before people overcame their fear of the ocean, currents acted as the subtle, yet constant, force in the movement of people from one part of the world to another.

POST-TEST

Questions 1 through 6 the same as in Pre-test.

7. Write an essay comparing the civilizations of ancient Egypt and the ancient Middle Americans, including religion, water transportation, and architecture.

   The similarities are many but should include:

   Religion - For both cultures the highest diety was the sun god, and their rulers were believed to be his descendants. They also had very powerful high priests who set the calendar, decided religious matters, and were the most knowledgeable in the arts and science.

   Water Transportation - Reed boats of similar construction were widely used in both cultures.

   Architecture - The religious buildings were shaped like pyramids with long mounting steps.

8. Look at a map of the world's ocean currents and pick out other currents which might possibly have been used by man in his movements from one continent to another.

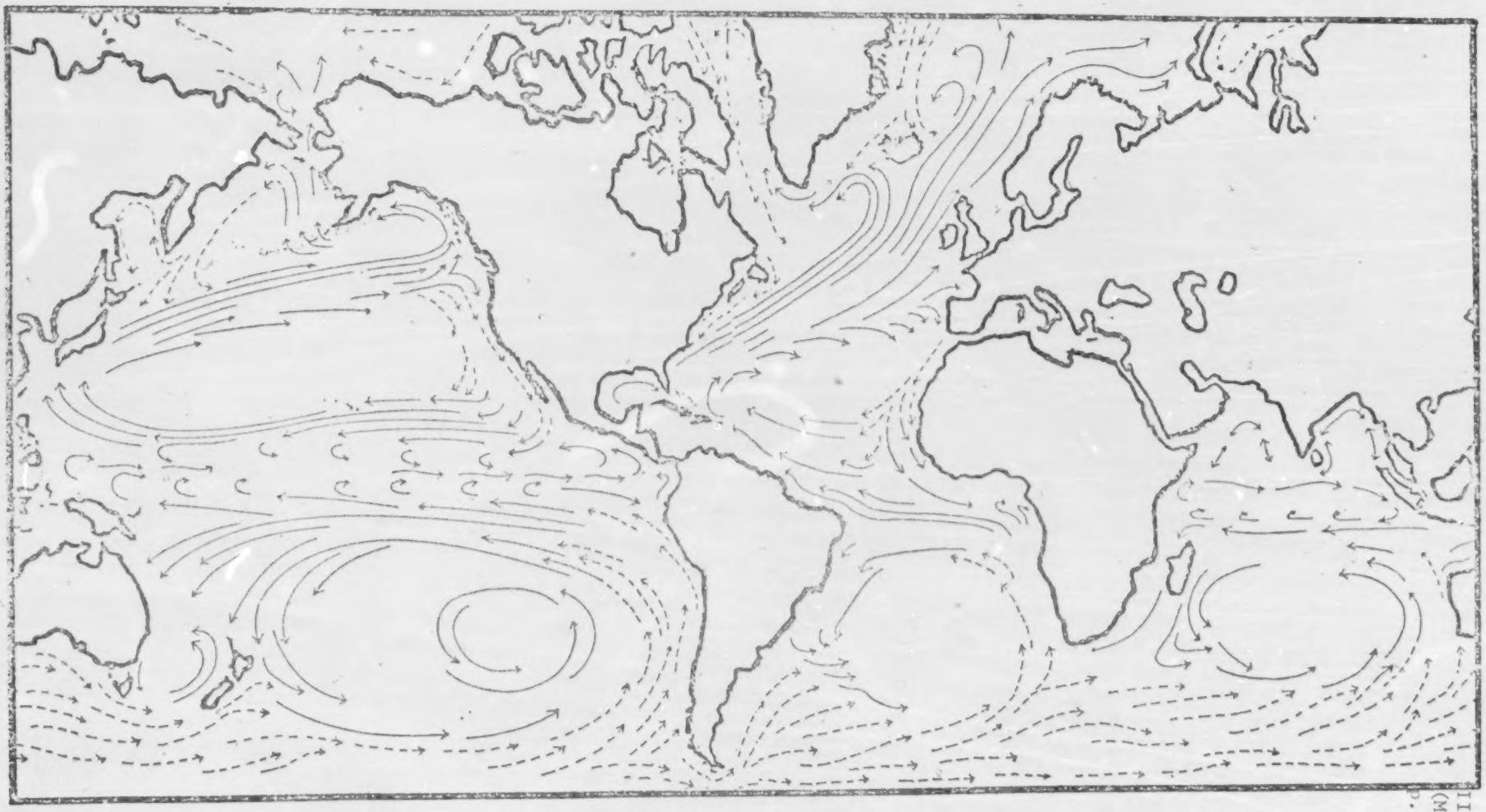
   Some possibilities are:

   Japan (Kuroshio) and North Pacific Currents from Japan and China to the Hawaiian Islands and the west coast of North America.

   Humboldt and South Equatorial Currents in the South Pacific Ocean from the west coast of South America to the islands of the Southern Pacific and Australia.

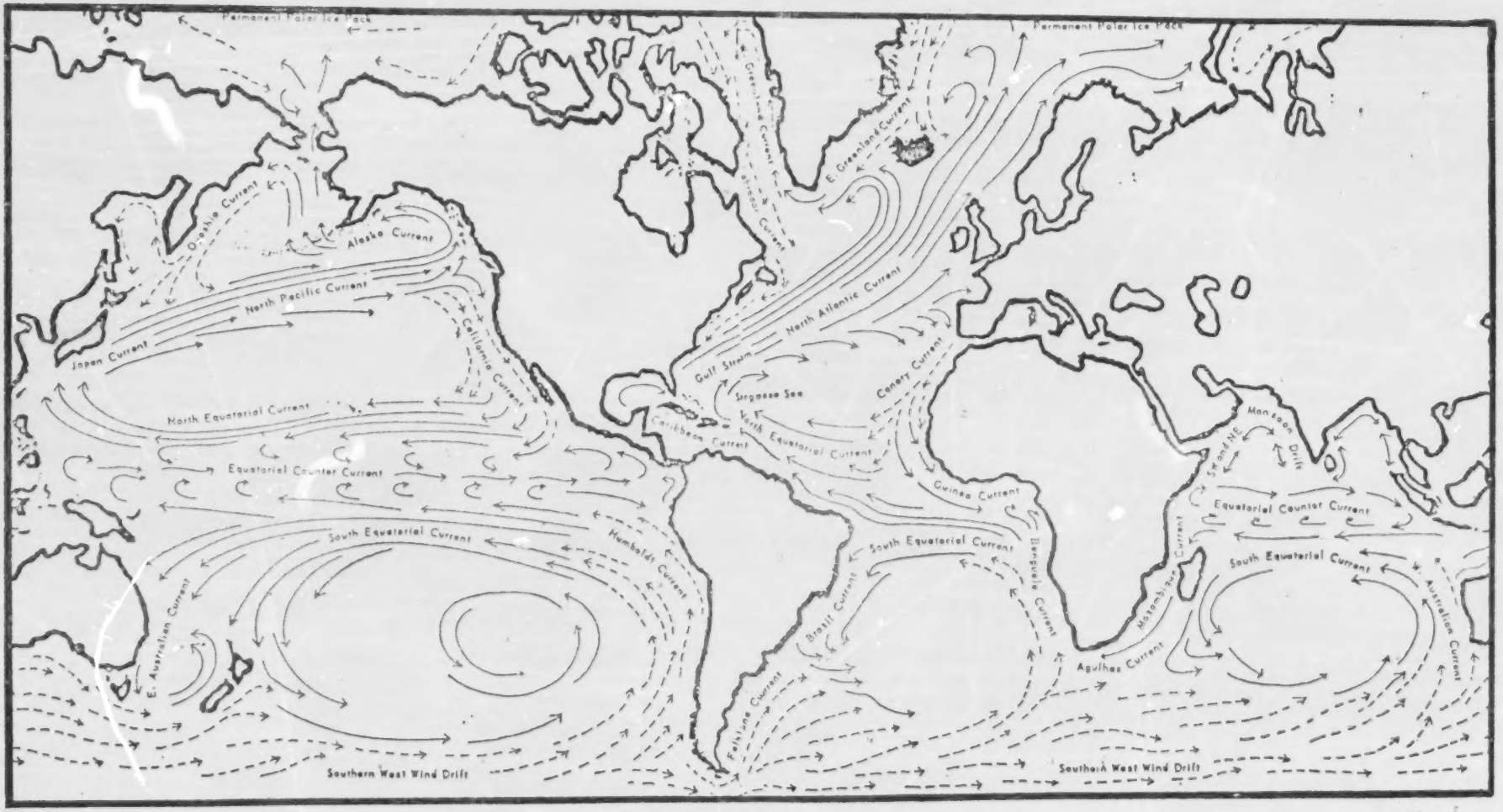
   South Equatorial and Brazil Currents in the south Atlantic Ocean from the west coast of Africa to the east coast of South America.

MAJOR OCEAN CURRENTS OF THE WORLD



WARM CURRENTS - ——
COLD CURRENTS - - - -

MAJOR OCEAN CURRENTS OF THE WORLD



WARM CURRENTS - ———
COLD CURRENTS - - - -

THE CORIOLIS EFFECT

The direction of ocean currents is determined by a force named after Gaspard Gustave de Coriolis who proposed its existence in 1835. He noted that the rotation of the earth affects the motion of objects moving over its surface. In the Northern Hemisphere this causes ocean currents to move toward the right, or in a clockwise direction. In the Southern Hemisphere the effect is just the opposite; ocean currents tend to move counterclockwise.

Before we continue, the question of how these currents are started needs to be answered. The currents of the ocean can generally be divided into two groups: surface currents, which may run 50 to 1000 meters deep, and bottom currents. The movement of surface currents is almost entirely dependent on the winds; bottom currents are caused by salinity and temperature differences.

The winds are caused by differences in thermal energy of air masses; this energy is determined by the temperature of the earth's surface, be it land or water, which in turn depends on the energy from the sun. The sun's rays strike the earth most directly near the equator. Consequently, the surface of the earth is warmest there. The air over the equatorial region is warmed by this heat and it rises and expands. This causes high altitude winds flowing to the north and south.

Assume for a moment that the earth did not rotate. The winds would then be driven to the poles, losing heat to the earth and outer space. At the poles, the winds would be completely cooled, becoming denser and heavier. Here the action would be the reverse of that at the equator; the dense air would fall to the earth and flow back to the equator. The resulting system would resemble that pictured in Figure 15.

The rotation of the earth introduces the Coriolis effect. An explanation of this effect can best be understood by examining the dynamics of a rotating sphere. At the equator (0° latitude), the circumference of the earth is approximately 25,000 miles. Since the earth rotates once every 24 hours, the speed of an object on the equator is just over 1,000 miles per hour (divide 25,000 miles by 24 hours.) At 30° north and south latitude, the circumference of the earth is only 21,750 miles. Since the earth's surface at this latitude also rotates once in 24 hours, the surface speed is only 906 miles per hour. Farther north and south the speed of the earth's surface lessens accordingly, as shown in the following table.

Degrees Latitude North and South	Circumference of the Earth at the Given Latitude	Speed of the Earth's Surface at the Given Latitude
0°	25,000 miles	1040 m.p.h.
30°	21,750 miles	906 m.p.h.
45°	17,760 miles	740 m.p.h.
60°	12,510 miles	523 m.p.h.
90°	0 miles	0 m.p.h.

The heated air at the equator has an eastward speed equal to that of the earth's surface, 1,040 miles per hour. Therefore, this air has no net eastward gain. As these air masses travel northward and southward, the surface of the earth underneath them is moving eastward with less speed. The air masses, however, are still moving eastward with their equatorial speed. Consequently, the air masses tend to curve east, that is, to the right in the Northern Hemisphere, and to the left in the Southern Hemisphere. Remember that these air masses leaving the equatorial region are at high altitudes and have no contact with the oceans.

Due to the specific size, shape, and rotational speed of the earth, the equatorial winds are curved directly east at 30° north and south latitudes. The winds literally crowd together; further, they lose some of the heat gathered at the equator. This cooling and crowding causes the air to become dense and sink. (See Figure 16.) Some of this fallen air travels back toward the equator to replenish that which was heated. Other fallen air at 30° north and south latitudes travels in the opposite direction toward the poles. These polar-bound winds meet cooled air from the poles which is flowing back toward the equator. This "collision" occurs at about 60° north and south latitudes. The only direction these air masses can move is up. After rising, some of the air goes back toward the equator, and some goes toward the poles. All the above processes create the six donut-shaped wind systems pictured in Figure 16.

Only those winds closest to the earth's surface generate the surface ocean currents. Figure 17 shows the direction of these winds, all the result of the Coriolis effect. Notice that regardless of their direction, in the Northern Hemisphere they curve to the right and in the Southern Hemisphere they curve to the left. The directional flow of the surface currents of the oceans is due not only to these winds, but also to the Coriolis effect acting on the water itself. Other factors determining ocean current direction are the shape of continental coasts and the contour of the ocean floor.

Over the centuries, sailors have learned to make use of these wind and current systems to speed them from continent to continent. They call some of these winds "easterlies" and "westerlies." These names refer to the direction from which these winds blow. Thor Heyerdahl used these wind and current systems to make the trans-Atlantic crossings in the reed boat "Ra."

ACTIVITIES:

1. Purpose: To show that heat makes water less dense.

   Materials: drinking glass, pill bottle, ink or dye, medicine dropper

   Procedure: Fill the glass nearly full with COLD water, then fill the bottle 2/3 full with COLD water. Using the medicine dropper, add ten drops of ink to the pill bottle, and carefully place it, right side up, in the glass. Because the water in both the glass and bottle are cold, nothing will happen.

   Now empty the bottle and refill it 2/3 full of hot water. Put in drops of ink, as before, and set the bottle in

the glass. At once, an inky stream will rise from the bottle. Because the water is hot, it is less dense than the cold water in the glass.

2. Purpose: To show that currents exist in a glass of water

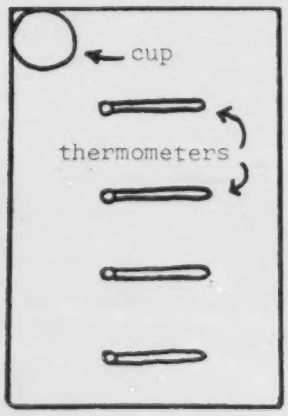
Materials: drinking glass, ink or dye, medicine dropper

Procedure: Fill the glass almost full with WARM water, and let it stand until it is still. Now carefully add one or two drops of cold ink to the surface. It moves downward and makes beautiful patterns. The ink is denser than the water and will replace the water below. This is how the currents near the poles are started.

3. Purpose: To show currents due to temperature differences in an ocean model.

Materials: large rectangular baking dish, four aquarium thermometers, paper cup with several small pin holes in the bottom, masking tape, crushed ice (enough to fill the paper cup), vegetable dye, bits of paper.

Procedure: Tape the paper cup in one corner of the baking dish so that there is about 1/2 inch between the bottom of the dish and the cup. Place the thermometers parallel and evenly spaced on the bottom of the baking dish as shown on the left. Tape the thermometers in place. Add enough water so that the bottom of the paper cup is covered. Let the apparatus sit until there is no movement in the water. Read each thermometer and record the temperature since it is temperature change that will concern us. Fill the cup with ice and add 5-10 ml of vegetable dye. Record the thermometer readings at five-minute intervals for 30 minutes. Place a bit of paper on the water in the corner opposite the ice. In what direction does it move? If you cannot see a bottom current, gently heat the baking dish opposite the ice to increase the current and make it easier to follow. What happens to the bottom current when it reaches the opposite side of the dish? Why? Which thermometer was the last to show a temperature drop? (The dye should show the existence of a bottom current while the paper should show the direction of the surface current.)



4. Purpose: To become familiar with the world's surface ocean currents and the lands along which they flow.

Materials: an outline map (the map on p.8 will do) of the world showing unlabeled ocean currents.

a labeled map of currents of the world

two different colored pens or pencils

Procedure:

1. Print the principal currents' names on your outline map.
2. Assume that all equatorial currents, and all currents flowing away from the equator are warm. Show these currents by going over their arrows in the color you assign to warm currents.
3. Assume that all polar currents and all currents flowing from the poles into lower latitudes are cold. Go over the arrows of the cold currents with your other color.
4. Label major land areas on the map.
5. Answer the following questions:

A. Using the terms clockwise and counterclockwise, compare the direction of the principal currents in the Northern and Southern Hemisphere oceans.

Currents in the Northern Hemisphere move clockwise; currents in the Southern Hemisphere move counterclockwise.

B. Why are the trade winds held responsible for the westward flow of the equatorial current?

The trade winds blow <u>from</u> the northeast in the northern hemisphere and <u>from</u> the southeast in the southern hemisphere, giving this direction and motion to their respective ocean currents. The Coriolis effect causes the equatorial currents to flow westward.

C. How do warm and cold currents affect the land masses they flow past?

Cold currents tend to cool the air masses over adjacent land masses; warm currents tend to warm the air masses over adjacent land masses.

D. Using the above information, speculate on the possibilities of cultural transfers other than those studied by Thor Heyerdahl.

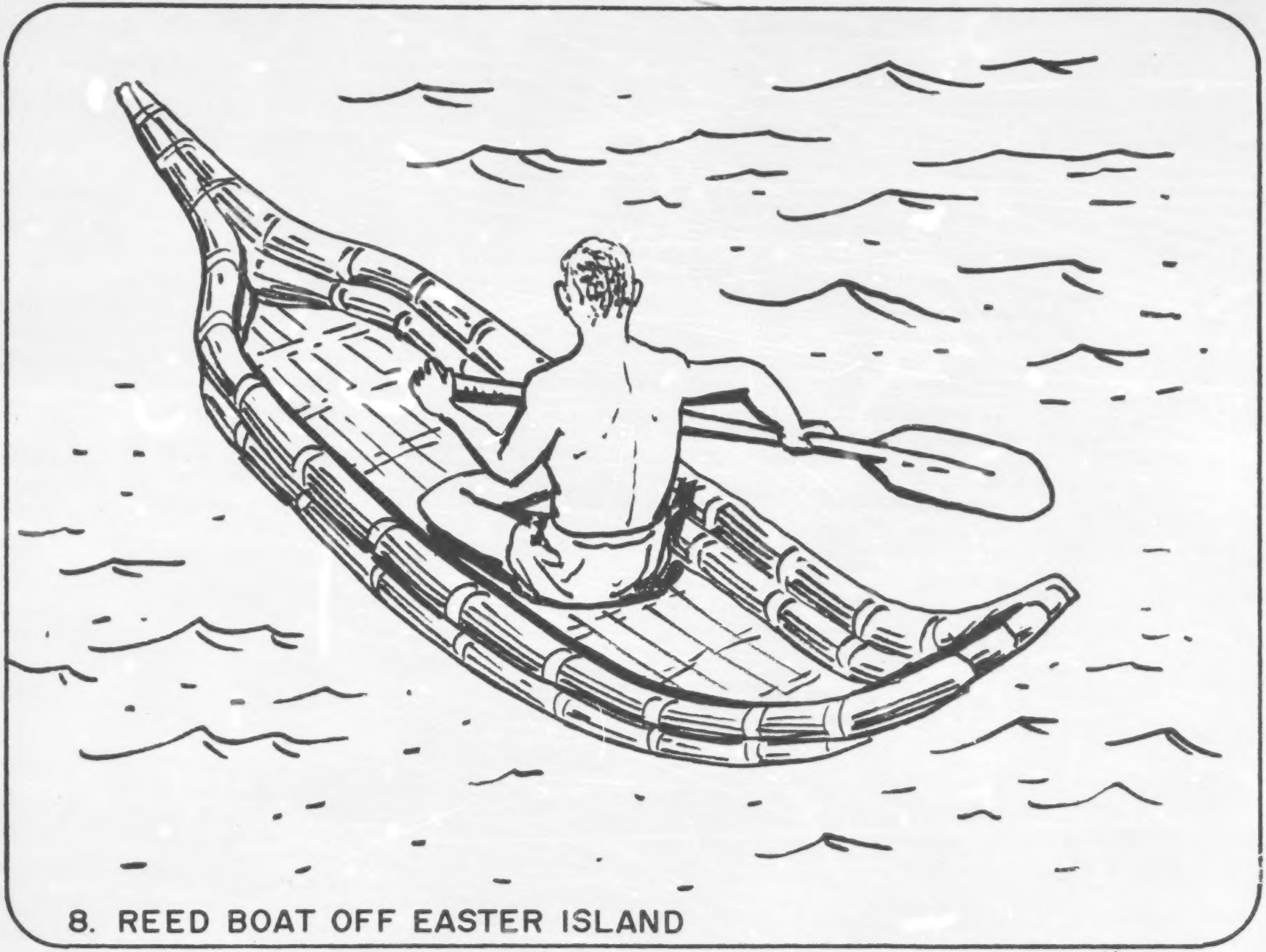
See answer to question No. 8 on page 7.

6. REED BOAT FROM LAKE CHAD

#6

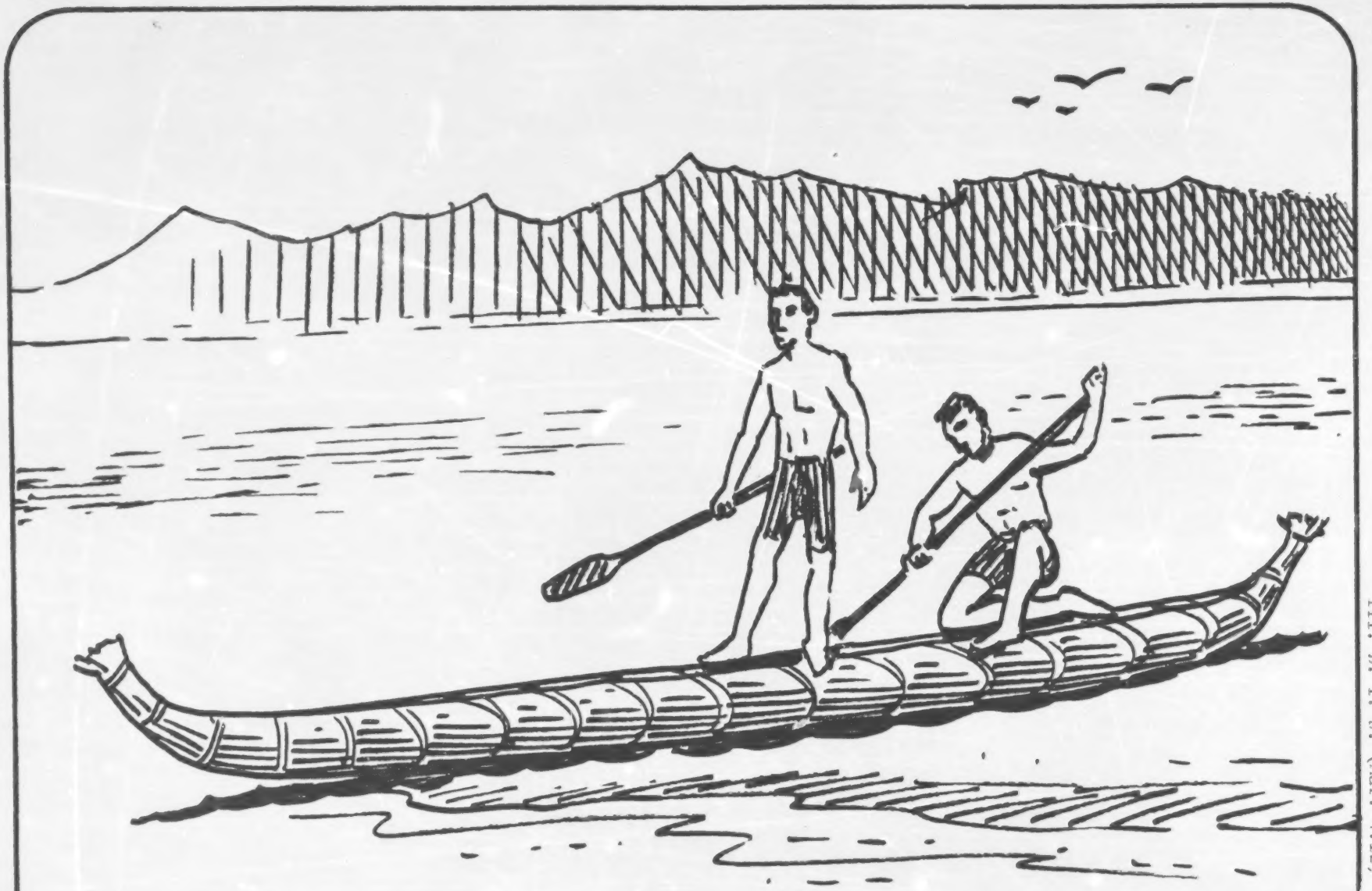
7. REED BOAT FROM LAKE TANA

#7



8. REED BOAT OFF EASTER ISLAND

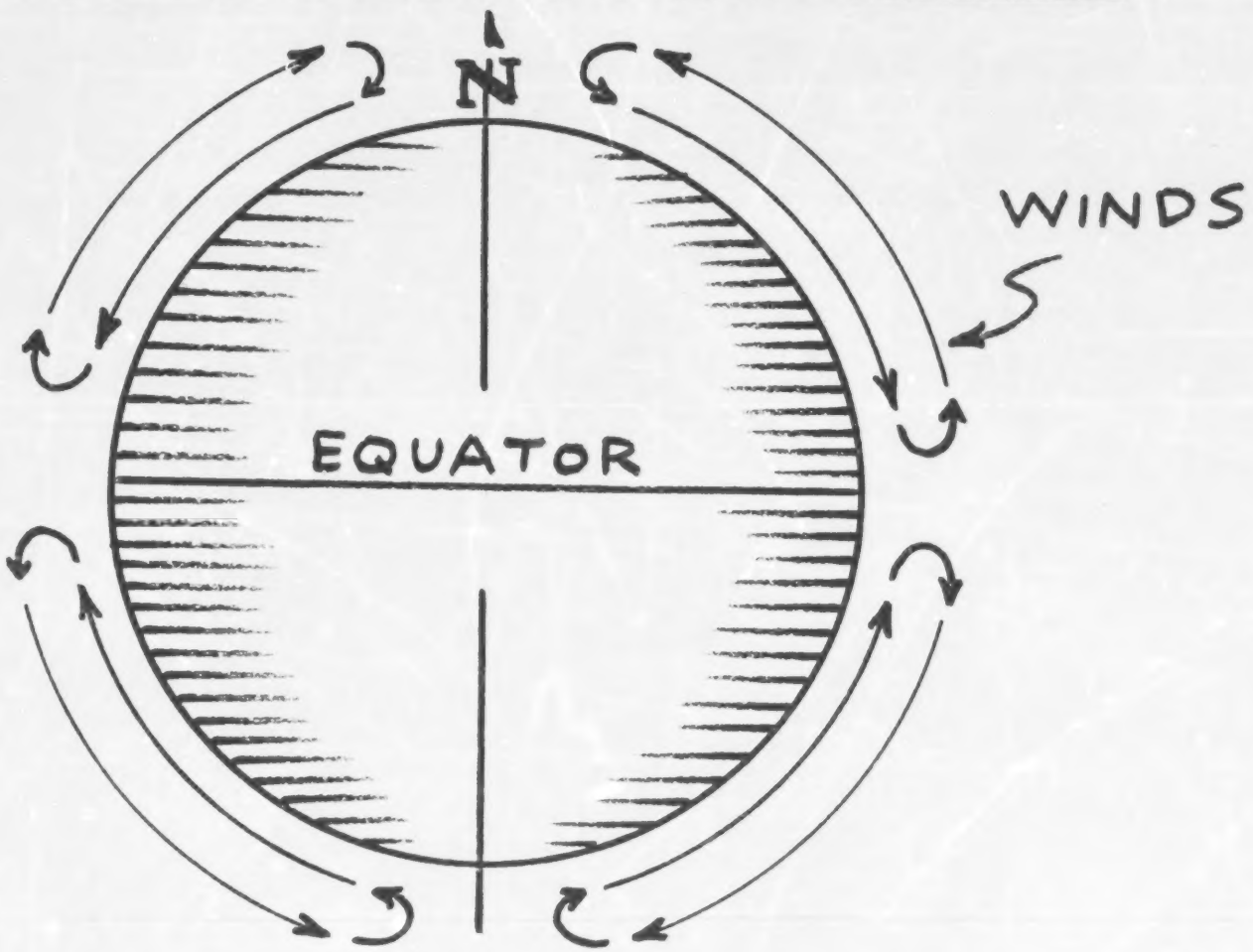
#8



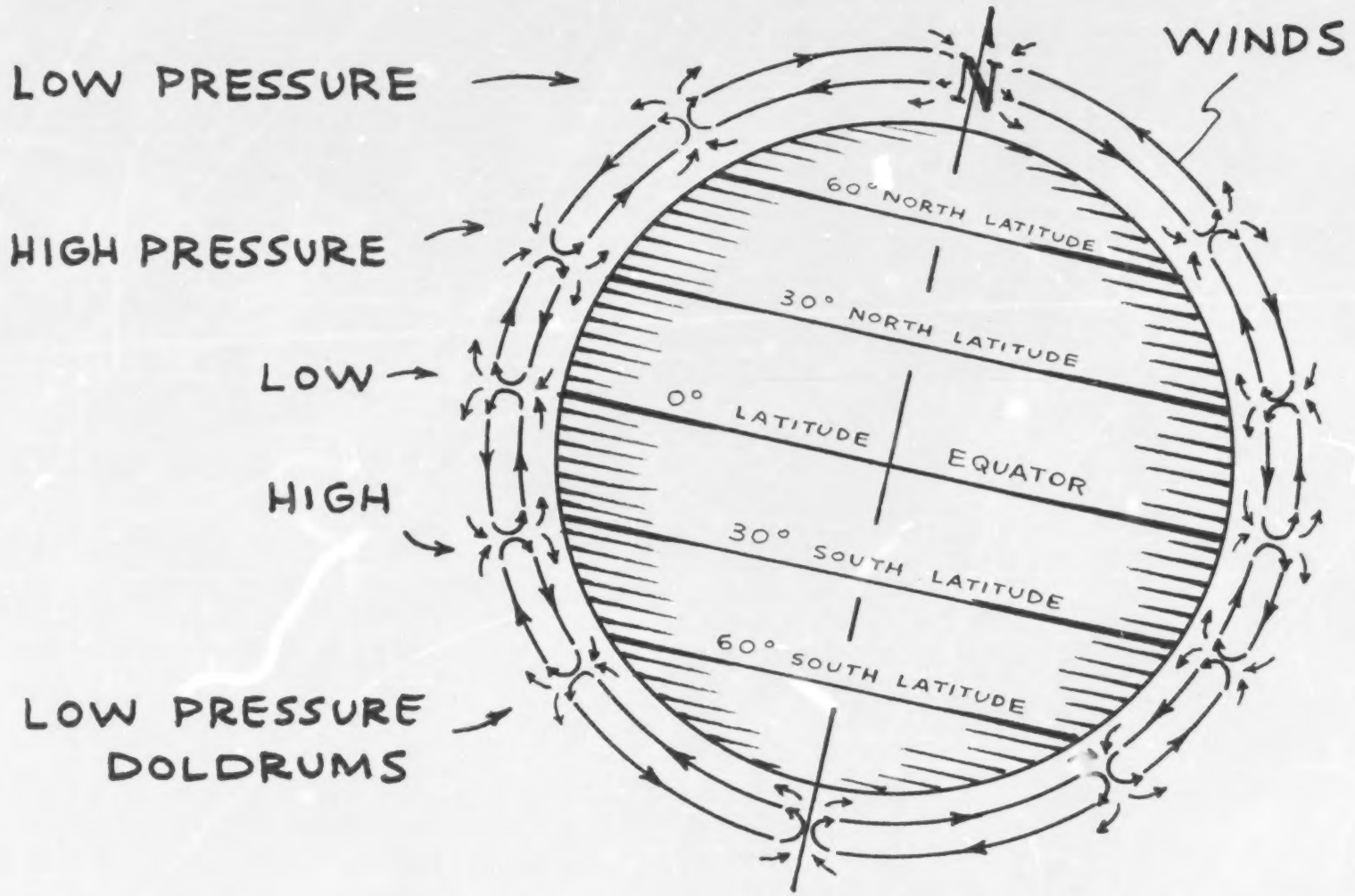
9. REED BOAT IN THE GULF OF CALIFORNIA

#9

WINDS - IF EARTH DID NOT ROTATE



ACTUAL WINDS ON ROTATING EARTH



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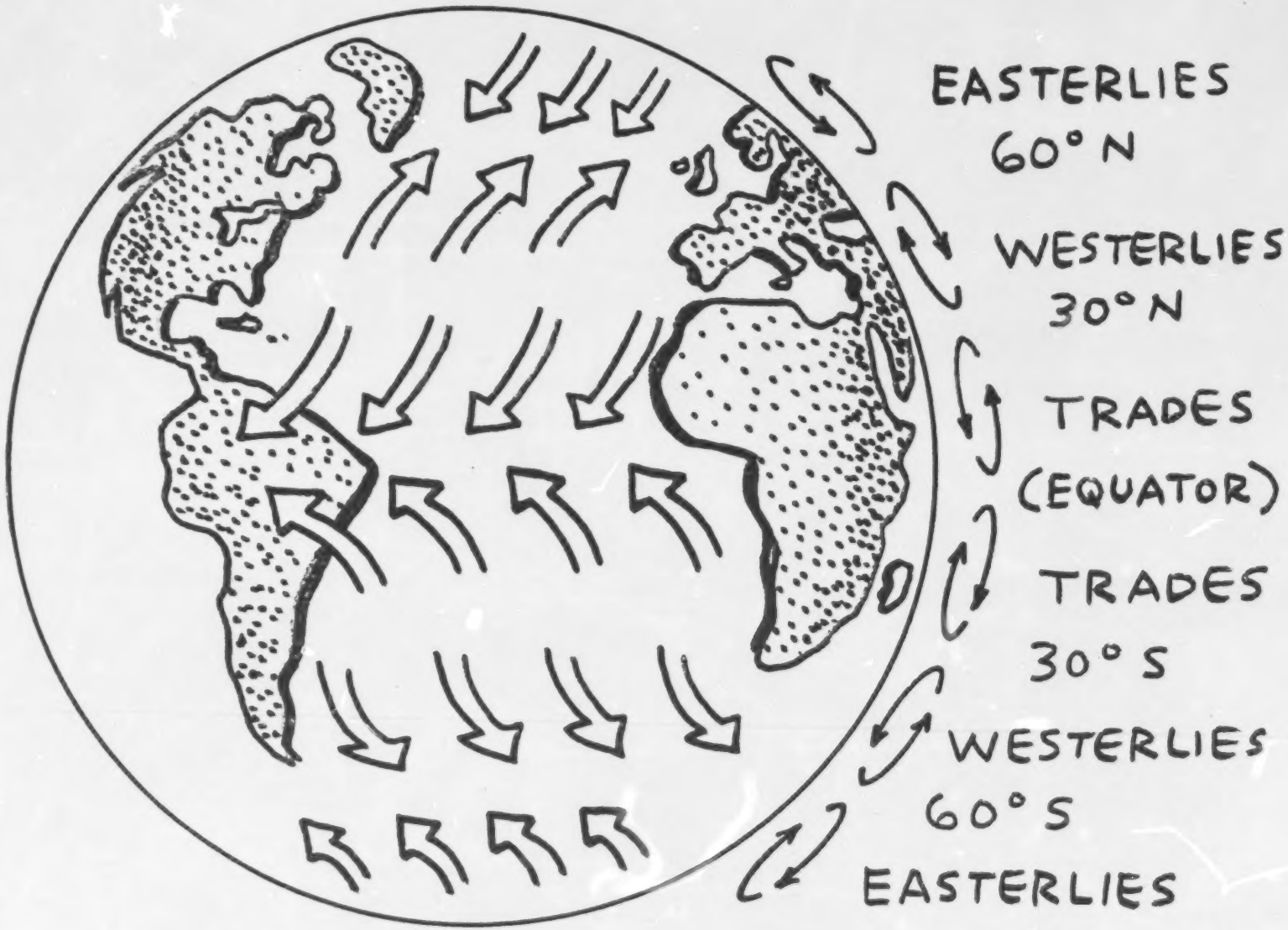

17. SURFACE WINDS ON A ROTATING EARTH

#17

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THE "RA" EXPEDITIONS: THE PAPYRUS REED

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B. The availability and utilization of resources contributed to the differentiation of life styles.

1. The invention of agriculture stimulated the differentiation of roles and led to the growth of technology.

b. INDIVIDUALS RELEASED FROM FOOD PRODUCTION DEVELOPED SPECIALIZATIONS RELATED TO AGRICULTURE.

**MARINE CONCEPT: 4.12

4. Man is part of the marine ecosystem.

4.1 The marine environment has affected the course of history and the development of human cultures.

4.12 PROXIMITY TO THE OCEANS AND THE AVAILABILITY OF MARINE RESOURCES HAVE INFLUENCED THE CULTURES OF MANY SOCIETIES.

SUBJECT: Biology, Social Studies

GRADE LEVEL: 6-12

CLASS PERIODS: 1-2

AUTHORS: Laggner and Osborne

Note to the Teacher:

The scope of this lesson as it stands is of necessity limited by lack of time and space. The main points surrounding the work of Thor Heyerdahl have been covered, but this is by no means intended to be the final word. We sincerely hope that the teachers will use this material as a starting point from which to generate critical insight and interest among their students. A reasonable bibliography is provided to help the teacher make this lesson plan complete for the students.

This learning experience is designed to be used in conjunction with:

III.B.1.b. (Mar. 4.12) The 'Ra" Expeditions: The Archaeological and Anthropological Background, and

III.B.1.b. (Mar. 4.12) The "Ra" Expeditions: The Coriolis Effect

* From A Conceptual Scheme for Population-Environment Studies, 1973. Cost $2.50.
** From Marine Environment Proposed Conceptual Scheme, 1973. No charge.
Both conceptual schemes are available from Robert W. Stegner, Population-Environment Curriculum Study, 310 Willard Hall, University of Delaware, Newark, DE 19711.

THE "RA" EXPEDITIONS

LEARNING OBJECTIVES

1. Students should have an idea of the current debate going on in the field of archaeology between the school of isolationism and that of diffusionism.

2. Students should have an understanding of the part Thor Heyerdahl's trans-Atlantic expeditions played in the debate.

3. Students should have an understanding of the history and characteristics of the papyrus reed.

4. Students should have an understanding of how the natural system affects our lives by providing materials with which to build things.

Note: This lesson will be more successful for the students if they have some knowledge of the "Kon-Tiki" and "Ra" expeditions.

TEACHER BACKGROUND

This lesson will use The "Ra" Expeditions, by Thor Heyerdahl, as a basis for inquiry into the linking of the ancient Mediterranean civilization with those of the ancient Middle Americans via the North Equatorial Current. Although not completely necessary, it is recommended that the teacher read The "Ra" Expeditions, as well as the other source material listed in the bibliography.

Columbus will never lose the credit for discovering America, but it must be remembered that he did not land on an empty beach. The perpetual trade winds and trans-Atlantic currents carried the "conquistadores" who followed Columbus to Mexico and Central America where they found organized Indian communities. The people the "conquistadores" found were the Aztecs of Central Mexico and the Incas, whose empire stretched from Panama, down the western coast of South America, to present-day Chile.

These pre-Columbian (meaning the time before Columbus' discovery) peoples had knowledge of the exact position of the equator, the equinox, the planets, and the stars. Their calendar was superior to that of the Old World. Their accomplishments also included surgery on the skeleton, as well as on the brain; construction of paved roads, aqueducts, suspension bridges, and pyramids; preparation of mummies; production of drugs; and the spinning, dyeing, and weaving of cotton cloth finer than the best in Europe.

The two trans-Atlantic expeditions of Thor Heyerdahl aboard the reed boat "Ra" were undertaken in part to help resolve an old battle between two schools of thought in the field of archaeology. The first of these schools, the isolationist, generally believes that similarities between two cultures do not mean that there was direct contact. For this to be, there must be historical (usually meaning written) or archaeological (usually meaning building sites and artifacts) proof. The implication here is that similarities between two cultures having no record of contact developed coincidentally. The other of the two schools, the diffusionist, believes that, except in rare cases, similarities between two cultures can be traced to diffusion, by means unknown, of ideas from one to the other. The diffusionists accuse the isolationists of holding a theory too narrow to explain cultural similarities. Further, they argue that their theory of diffusion is just as tenable as the isolationists' theory of coincidence in cultural similarities. However, the isolationists have a strong argument in questioning whether two or three castaways could significantly affect another culture.

Concerning the "Ra" expeditions, all archaeologists agree that the ancestors of American Indians were Stone Age peoples who crossed the frozen Bering Strait. The argument between the two schools centers around whether ancient American Indians had any outside help in developing to the point at which the Spanish found them in A.D. 1500. The diffusionists have postulated that there was contact with the ancient civilizations around the Mediterranean, giving as evidence such parallels as sun worship, belief that the king is descended from the sun god, mummification,

pyramid-type buildings oriented toward the movement of the sun, sophisticated mathematics and geometry to design and build pyramid and temple structures, various agricultural and architectural techniques, and reed boats. The isolationists believe that this evidence is purely circumstantial. If the Mediterranean cultures developed certain ways of doing things, why couldn't another culture separated by 2500 miles of ocean? The questions in this debate are far from settled, and even an attempt such as the "Ra" expeditions has not substantially altered the arguments of both schools.

Like the people of the ancient Mediterranean, the ancient Middle American Indians did not separate science and religion. A star, a day of the week, a number, and a god might all represent a single concept. Raimi, the sun god, was the highest of the Incan gods. He was the mathematical representation of the number 1. Viracocha, the mythical founder and high priest of the Incas, was said to be the white-skinned son of Raimi. The mythical founder of the Aztecs was Quetzalcoatl, who was white-skinned and was a god fathered by the sun. A similar pattern holds for Kukulcan, the religious founder of the Mayas. This is similar to the religion of the ancient Egyptians. The Pharoahs were believed to be descended from the Egyptian sun god, Ra.

If the founders of the royal line of the early Middle American Indians were white-skinned, then it should be no surprise that the "conquistadores" found a white royal family ruling a dark-skinned people. This had been done by inbreeding. The royal family would marry only among themselves. A separation was thus enforced between the rulers and the ruled, which encouraged a mystique of divinity to surround the royal family.

When members of the royal family died, they were buried in a manner similar to that of the ancient Egyptians. The bodies were mummified and buried in temples similar to the pyramids. If the king died, his servants were slain and buried with him so they would be able to serve him in the next world. The story of the deceased was written on the walls of the tomb.

Thor Heyerdahl notes that on both sides of the Atlantic the tomb writings often contain scenes of reed gathering, reed boat construction, and kings sailing in reed boats. The Spaniards found the South American Indians riding on small reed vessels that were nothing more than a tusk-shaped roller (see picture #9). The boats carried one or two men straddled as on a horse, their legs drifting in the water. Other reed boats were reported to be constructed as sailing vessels, able to support a crew of twenty-four. Heyerdahl believes that these vessels are the same as those unearthed at the pyramid of King Cheops in Egypt.

The reed is a tender water plant that can be bent by a child. It cannot be joined together with screws or nails. Dried reeds are tied together in bundles to form boats. Egyptian boats were built from the papyrus reed, Cyperus papyrus. The Western counterpart of this plant is Scirpus totora. Both reeds have all but vanished from the areas where they once flourished, yet in a few areas of the world reed boats are still the basic means of transportation.

The people of Lake Chad in Chad, Africa; Lake Tana in Ethiopia, Africa; Sardinia; Lake Titicaca on the border between Peru and Bolivia; and Easter Island still build their vessels in the shape of the Inca rollers (see pictures #6 through 9).* Reed boats sit high in the water and need no bailing because excess water runs out through the spaces between the reeds.

Thor Heyerdahl notes the superiority of the reed vessels that have persisted through 5,000 years of history. Since he is sympathetic with the diffusionist school of thought, Heyerdahl set out to prove that reed vessels could have easily brought the culture of Egypt to the New World. To do this Heyerdahl employed boat builders from Lake Chad to construct his vessel. It was fashioned from papyrus reeds which came from Lake Tana at the source of the Nile. The vessel was named "Ra" after the Egyptian sun god. The "Ra" was patterned after the large reed skiffs unearthed at the pyramid of King Cheops.

On May 25, 1969, the "Ra" set sail from Safi, Morocco, with a crew of seven. During the first two days of the voyage across the Atlantic Ocean, the winds stripped the "Ra" of her sail and oars. She was able to drift with the Canary Current and later the North Equatorial Current. On July 16, the crew was forced to abandon the sinking "Ra" east of Barbados. Her stern had not been constructed as a single unit with the rest of the ship, and the boat had started to disintegrate and sink. During the following year, Heyerdahl had a second reed boat constructed. The "Ra II" was built as a single unit and successfully crossed in the path of "Ra I" during the summer of 1970.

Despite his efforts, Heyerdahl realized that a trans-Atlantic crossing is still theoretical. He proved that reed boats are quite seaworthy, but the archaeological argument still continues.

* Because this learning experience was developed in conjunction with two related learning experiences (The "Ra" Expeditions: The Archaeological and Anthropological Background and The "Ra" Expeditions: The Coriolis Effect"), one set of pictures was developed for use with all three. Only pictures #6 through 9 are included with this unit (on pp. 10-13).

PAPYRUS REED

BACKGROUND

Papyrus is a member of the sedge family, to which bulrushes belong. It is classified as follows:

Old System *		
Kingdom		
Division (Phylum)	Tracheophyta	(trā - kē - ahf' - eh - teh)
Subdivision	Spermopsida	(sper - mop' - sid - ah)
Class	Angiospermae	(an' - jē - ō - sperm - ē)
Subclass	Monocotyledoneae	(mon - eh - kot - eh - lē' - deh - nē)
Order	Graminales	(gram - eh - nāl' - ēz)
Family	Cyperaceae	(sip - eh - rā' - cē - ē)
Genus	Cyperus	(sip' - eh - rus)
Species	papyrus	(pah - pī' - rus)

New System +		
Kingdom	Euphyta	(ū' - feh - tah)
Division	Magnoliophyta	(mag - nōl - ē - ahf' - eh - tah)
Class	Liliatae	(lil - ē - ā - tē)
Order	Cyperales	(sip - ah - rā' - lēz)
Family	Cyperaceae	(sip - eh - rā' - cē - ē)
Genus	Cyperus	(sip' - eh - rus)
Species	papyrus	(pah - pī' - rus)

The papyrus reed grows on muddy banks or in shallow water to a height of from three to ten feet. The stalk is about five inches in diameter and has a tapering, triangular form. The main stem (stolon) extends underground horizontally for fifteen feet. Small roots anchor the plant in the mud.

Papyrus flourished along the banks of the Nile 10,000 years ago. The greatest concentrations were at the Nile's source, in the Sudan. Its later occurrence in southern Italy and Sicily resulted from a specimen sent as a gift from Ptolemy Philadelphus to Hieronymus II, King of Syracuse, in 250 B.C.

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*Benson, L.D. 1962. Plant Taxonomy: Methods and Principles. Ronald Press Co., New York.

+Cronquist, A. 1968. The Evolution and Classification of Flowering Plants. Houghton Mifflin. Boston.

Papyrus grows in dense populations. The older vegetation floats in dense aggregations around the living plant. The name for this thick form of water cover is sudd, from which the Sudan got its name. Water beneath the sudd of the papyrus has a low oxygen content. This causes the depletion of the growth of most other plants and aquatic animals in areas near papyrus. For this reason, its growth is considered harmful in natural waters, irrigation systems, and in areas where subaquatic crops are grown. Papyrus closes navigable channels and obstructs fishing.

The Nile was the lifeblood of the ancient Egyptian culture. This 4,187-mile-long river (measured from its longest tributary) was the center of ancient Egypt's food production, transportation, commerce, and recreation. The effects of the sudd caused by papyrus threatened Egypt's future. For this reason, the papyrus reed has been continuously removed from the Nile banks by weeding until the plant is all but extinct. Only in the vast shallows of the Sudan does the papyrus remain in abundance.

Historically the papyrus reed has been used for fuel and to make ropes, baskets, mats for floor and furniture covering, shoes, and boat sails. Papyrus skiffs were the vessels of the ancient Nile. The most common use of papyrus was for paper. The papyrus was also used for human consumption; the raw reed could be chewed to yield a juice. Often the papyrus was stewed or roasted.

ACTIVITIES

1. Visit a local marsh. Observe the growth of Phragmites communis, or the common reed, the tallest grass found along most Delaware marshes. It grows from four to nine feet high with a stiff, erect stem. This plant also forms sudd, and is often found growing with papyrus. (Phragmites communis is a member of the grass family, not the sedge family as the papyrus plant is.) Note the presence of sudd and decide whether it is inhibiting other plant and animal growth within the marsh.

Classification:

Kingdom	Euphyta	(ū' - feh - tah)
Division	Magnoliophyta	(mag - nōl - ē - ahf' - eh - tah)
Class	Liliatae	(lil - ē - ā' - tē)
Order	Cyperales	(sip - ah - rā' - lēz)
Family	Gramineae	(gram - in - ē' - ē)
Genus	Phragmites	(frag - mīt' - ēz)
Species	communis	(com - ū' - nis)

2. In the fall, collect a single complete plant of Phragmites communis. This should be done when the plants are dry and brown, with a graceful "tassel" or inflorescence. Do not collect more than one entire plant for your school because the "stand" should not be damaged by a lot of digging. At the same time, collect some of the "soil" or sudd and take it back to the schoolroom for study. Also, collect a bundle of reeds by cutting just above the soil. These will be used for raft building. Collect the reeds in such a way and in such a place that you do not deface the vegetation, i.e., do not create an unsightly defoliation of the roadside.

3. Place some of the phragmites "soil" or sudd near other growing plants to see if the sudd inhibits growth.

4. Use the stems to build a raft or boat by binding them together with twine. See The "Ra" Expeditions by Thor Heyerdahl. Other objects can be fashioned from the reeds, perhaps even a house.

5. Prepare an ornamental, dry arrangement of the graceful tops of the phragmites.

6. Study the botanical structure of the roots, stems, and leaves.

7. Study the life cycle of phragmites by reproducing it from roots and/or from seeds.

8. Try to establish a "phragmites environment" in your outdoor laboratory area. This will require analyses of soil, water, temperature, exposure to sun, etc.

Note:

Although phragmites is not as closely related to papyrus as some other marsh plants, the phragmites has a long tough stem and grows in abundance in many places. Remember that the purpose of this study is to relate the activities of humankind to the natural system in which we have developed our civilizations. The idea is to know that the natural system is capable of influencing our lives by providing materials with which to build things.

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7. Heyerdahl, Thor, "The Voyage of 'Ra' II," National Geographic, January, 1971, pp. 44-71.

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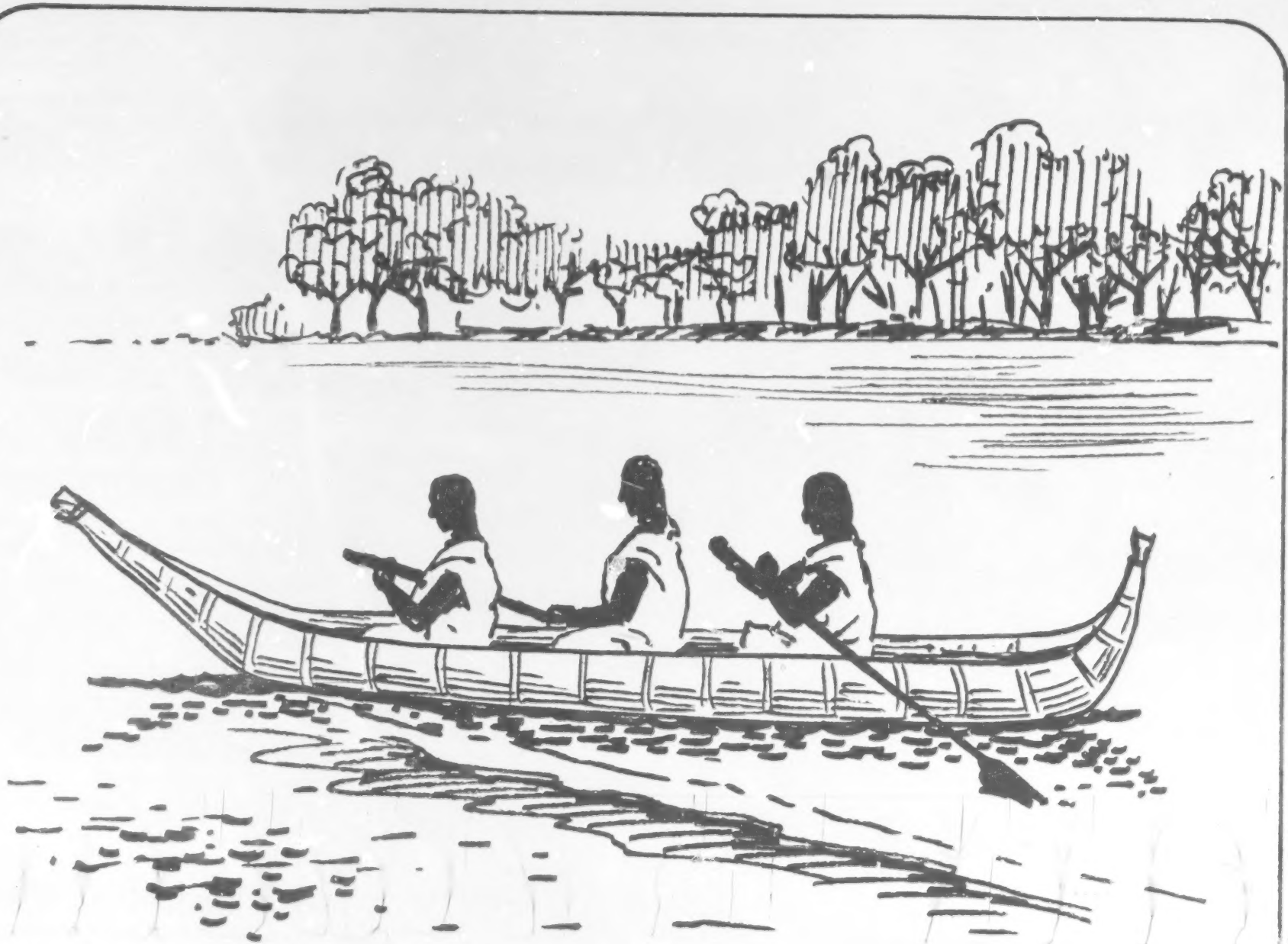
9. Wauchope, Robert, General Editor, Handbook of Middle American Indians, University of Texas Press, Austin, 1965.

6. REED BOAT FROM LAKE CHAD

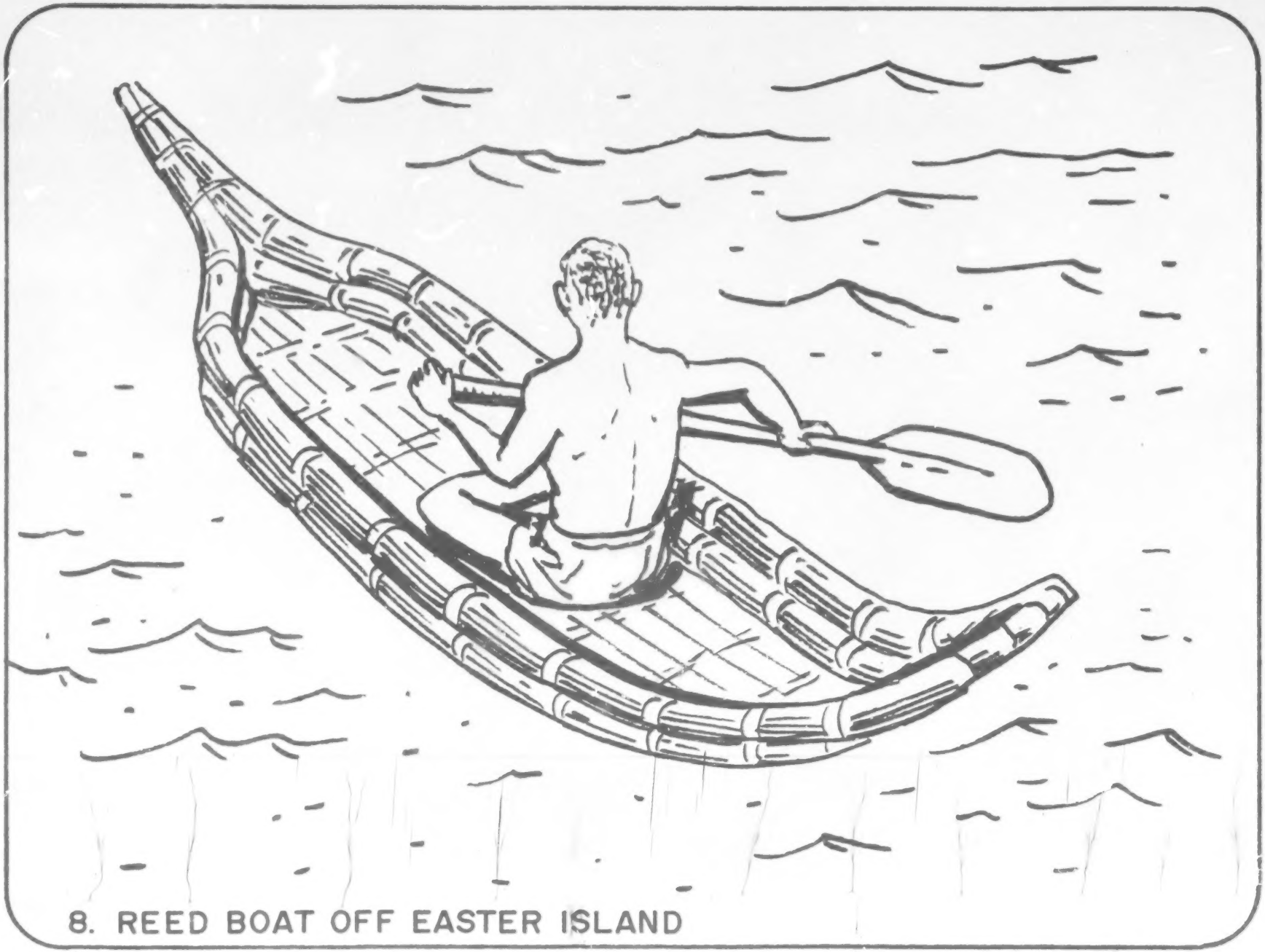
#6

Ill. B. 1. b. (Mar. 4.12) p. 10

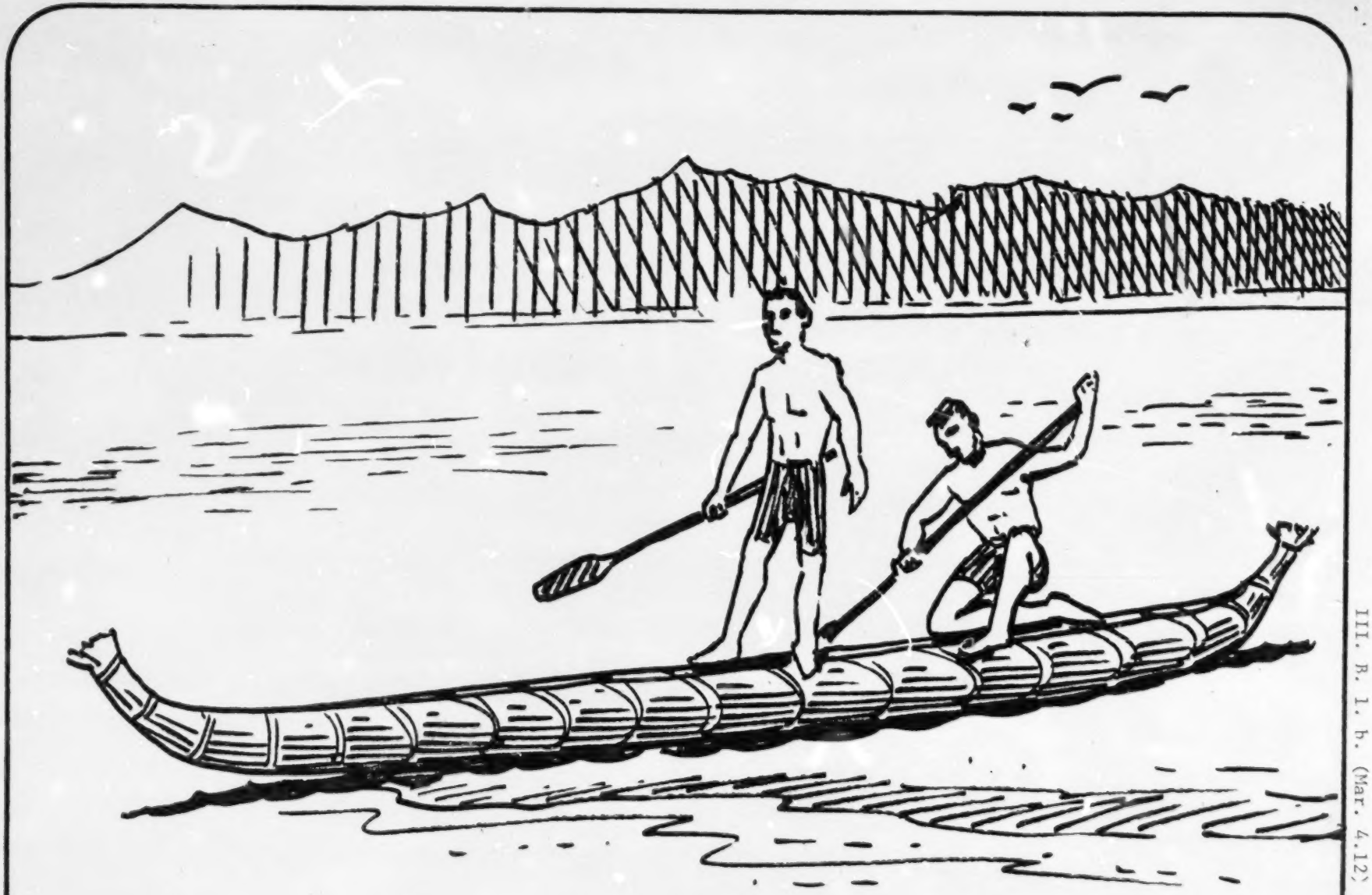


7. REED BOAT FROM LAKE TANA

#7



8. REED BOAT OFF EASTER ISLAND



9. REED BOAT IN THE GULF OF CALIFORNIA

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97

#9

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